S. HRG. 105–944

SALMON RECOVERY ON THE COLUMBIA AND SNAKE RIVERS

HEARING

BEFORE THE

SUBCOMMITTEE ON
DRINKING WATER, FISHERIES, AND WILDLIFE

OF THE

COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE

ONE HUNDRED FIFTH CONGRESS

SECOND SESSION

OCTOBER 8, 1998

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C O N T E N T S

SALMON RECOVERY ON THE COLUMBIA AND SNAKE RIVERS

THURSDAY, OCTOBER 8, 1998

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON DRINKING WATER, FISHERIES, AND WILDLIFE,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:30 a.m. in room 406, Senate Dirksen Building, Hon. Dirk Kempthorne [chairman of the committee] presiding.

Present: Senators Kempthorne and Chafee [ex officio].

Also present: Senators Craig and Smith of Oregon.

OPENING STATEMENT OF HON. DIRK KEMPTHORNE, U.S. SENATOR FROM THE STATE OF IDAHO

Senator KEMPTHORNE. Ladies and gentlemen, I'll call this hearing to order.

Welcome all of you. I look forward to the discussion that we'll have this morning, and I appreciate all of our witnesses that are joining us today. I also want to acknowledge and thank the Chairman of the Full Environment and Public Works Committee, Senator Chafee, for joining us this morning.

It is an interesting commute today—what normally is 35 minutes is now 1 hour and 20 minutes, and we are now here in dry areas, so we'll go ahead with our hearing.

I have called today's oversight hearing to bring us up to date on some developing issues in the complex, but vitally important, matter of restoring the runs of specific salmon and steel head to the Columbia–Snake River System.

The recovery of the salmon is intertwined with contrary goals, political and personal philosophies, and the economic realties of 21st century America. We have pursued the recovery of this fish with the wealth of a nation, and we have so far little or nothing to show for it.

The debate over salmon have centered around the use of water resources to provide an alternative to the operation of the Federal dams on the Columbia–Snake Rivers. The recovery of the salmon in the Columbia–Snake River system will never occur if the debate continues to focus solely on the dams. Recovery of the salmon must take into account all phases of the salmon's life cycle. We will not solve the 5,000 mile problem with a 100 mile solution. A new management philosophy must be utilized. A sharper focus on a number of factors is called for.

Recovery of the salmon will never be achieved by looking at just one problem or just one solution. The salmon will be restored to sustainable levels only by addressing each portion of their habitat during each phase of their life cycle.

If that were not enough of a challenge, any plan to recover the salmon must be adaptive and flexible enough to respond to changing conditions. We will not save the salmon with a silver bullet. We will not save salmon by ignoring the legitimate interests of the States, tribes, communities, families and the businesses that depend on the resources of the Columbia–Snake Rivers. Each sector will have to make concessions, and each State will have to do its part.

It has become common to see a chart depicting a precipitous decline of salmon and steel head since the last four dams were built on the Snake River. From a larger perspective, however, the observed declines began many years before them.

This is the Corps of Engineers' chart of salmon and steel head numbers in the Columbia–Snake River system that we commonly use. It is widely used to describe how the fish have declined since the introduction of the dams. When I first looked at this particular chart, I noticed two things—first, it appeared to me that the runs had largely declined before the first dam was built; and, second, somehow the Bonneville Dam appears on this chart in 1925, rather than in June of 1938. I checked with the Corps, and they attributed this to a computer error. They confirmed that the Bonneville Dam was indeed put on line and constructed in 1938.

More importantly, were the fish runs devastated by the building of the dams, especially the four lower Snake River dams? What I found was interesting, and I think, a little disturbing.

These next charts—and, again, these are—I don't know of anyone who will be able to see those numbers—but this table from the Corps of Engineers' Annual Fish Passage Report gives the number of salmon and steel head returning upstream past Bonneville. The point is I was surprised to find that the total returning salmon was many times smaller than those shown in the graph. The graph shows total returns declining from four million in 1940 to two million in 1995.

Table 20 shows total returns moving up and down annually around an average of about 600,000 fish between 1940 and 1997. I have drawn a line on the graph at 600,000 fish. This shows me that most of the decline in salmon returning to the river system occurred in the decades before we began building dams, and it seems that somehow we have been able to maintain returning numbers at a very low but steady 600,000 fish. Then I looked more closely at the fish returns in the lower Snake River. Now, here are the dates of each of the four lower Snake River dams—Ice Harbor was 1961, Lower Monumental was 1969, Little Goose, 1970, and Lower Granite, 1975.

Then on the next chart from Table 121 for Ice Harbor Dam, I found that instead of declining over time, the salmon returning have remained fairly steady. It appears they are now fluctuating around a 10-year average of 130,000 fish at Ice Harbor. Similar data are available from the Lower Granite Dam from 1975 to 1997,

which seemed to fluctuate around 108,000 fish. In fact, last year's return at Lower Granite was almost 133,000 fish.

Now, I do not pretend to be a statistician or fisheries biologist, but it does make sense to me that contrary to conventional wisdom most of the decline in the Columbia Snake River System fish occurred before 1935, and the runs of returning fish have remained at a very low but constant level.

Yes, we built dams and we continue the extravagant harvest of this fish both in the river and the sea. We introduced new predators, we made conditions easier for native predators and we have flooded the river with masses of cookie-cutter hatchery fish. I believe that while we debate at great length and in excruciating detail the future uses of four run of the river dams in the lower Snake River we're nearly ignoring several essential truths about salmon recovery. It is clear to me that we must look at ocean conditions, we must reverse the decline and genetic diversity of the salmon and steelhead runs, and we must get harvest and predation under control. Without these changes and management of the river, there is no hope that these changes will have much effect.

[The prepared statement of Senator Kempthorne follows:]

STATEMENT OF HON. DIRK KEMPTHORNE, U.S. SENATOR FROM THE STATE OF IDAHO

Good morning. I have called today's oversight hearing to bring us up to date on some developing issues in the complex, but vitally important matter of restoring the runs of Pacific salmon and steelhead to the Columbia/Snake River system.

The recovery of the salmon is intertwined with contrary goals, political and personal philosophies, and the economic realities of 21st century America. We have pursued the recovery of these fish with the wealth of a nation and we have, so far, little or nothing to show for it.

The debate over salmon has centered around the use of water resources to provide an alternative to the operation of the Federal dams on the Columbia and Snake rivers. The recovery of the salmon in the Columbia/Snake River system will never occur if the debate continues to focus solely on the dams. Recovery of the salmon must take into account all phases of the salmon's life cycle. We will not solve a 5,000-mile problem with a 100-mile solution. A new management philosophy must be utilized. A sharper focus on a number of factors is called for.

Recovery of the salmon will never be achieved by looking at just one problem or just one solution. The salmon will be restored to sustainable levels only by addressing each portion of their habitat during each phase of their life cycle. If that were not enough of a challenge, any plan to recover the salmon must be adaptive and flexible enough to respond to changing conditions. We will not save the salmon with a silver bullet. We will not save salmon by ignoring the legitimate interests of the States, tribes, communities, families and the businesses that depend on the resources of the Snake and Columbia rivers. Each sector will have to make concessions and each State will have to do its part.

It has become common to see a chart depicting a precipitous decline of salmon and steelhead since the last four dams were built on the Snake River. From a larger perspective however, the observed declines began many years before then.

[Display of chart of fish runs before Bonneville was built]

Yes, we built dams. And, we continued the extravagant harvest of this fish both in the river and the sea. We introduced new predators. We made conditions easier for native predators. And we flooded the river with masses of cookie-cutter hatchery fish.

I believe that while we debate at great length and in excruciating detail the future uses of four run-of-river dams in the lower Snake River, we are nearly ignoring several essential truths about salmon recovery. It is clear to me that we must look at ocean conditions. We must reverse the decline in genetic diversity of the salmon and steelhead runs. And we must get harvest and predation under control. Without these changes in our management of the river, there is no hope that other changes will have much effect.

In today's first panel we have asked three scientists and engineers to share with us some of their work on these essential issues. Our first witness, Dr. Roby began

an overview study of avian predation on the Columbia/Snake River system several years ago. In the course of that study, he discovered that one particular species, the Caspian tern, was having an inordinate effect on the outmigrant salmon smolts due to its preferred method of fishing and the location of its nesting colony. We are hoping to explore with today's witnesses the possibility of non-lethal means to control this excessive predation.

Our second witness is Dr. Cloud, a fish geneticist, who has been studying the genetic effects of hatchery fish on the wild runs of salmon and steelhead. In addition, Dr. Cloud has made a proposal for a gene bank for native Northwest fish that will give some insurance that we can preserve some of the declining genetic diversity for future use.

The third witness is Richard Fisher who works for the Voith Hydro Power generation company. In his work at Voith, Mr. Fisher oversees the development of new technologies, including the Advanced Hydropower Program authorized through the Water Resources Development Act.

In the second panel we will hear how our Agencies have been responding to these issues. I hope that as a result of this hearing we can look forward to new ways to incorporate information coming from our scientists and engineers.

We will hear from Colonel Eric Mogren of the Corps of Engineers how the agency has been responding to the avian predator issue, and the advanced hydropower technology opportunity.

Rolland Schmitten, representing the National Marine Fisheries Service will discuss the avian predator issue, the hatchery and harvest issues, and will have comments on advanced hydropower.

I want to note at this time that the Regional Director of the U.S. Fish and Wildlife Service that was invited has not been able to attend this hearing. I understand that she has recently assumed the Directorship, and that there are many urgent matters that require her attention. I have been assured that the Service wants to play a constructive role in crafting the final decision of the Interagency Task Force on the Caspian tern and recognizes the critical importance of this issue. The Service has asked David Wesley to be here today to answer our questions.

Chart #1

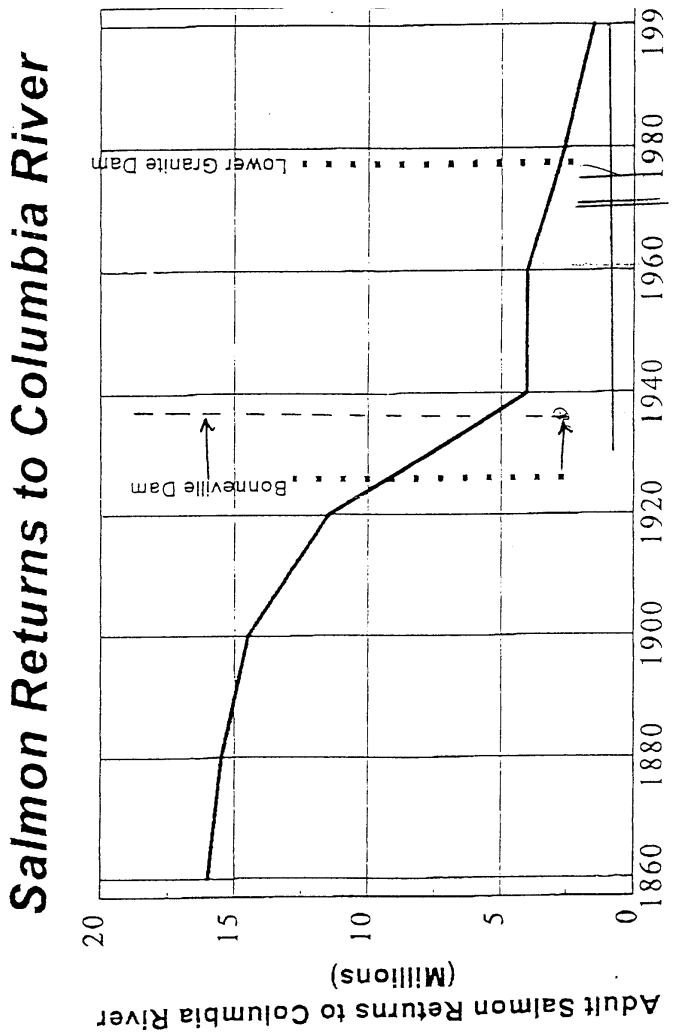
Salmon Returns to Columbia River
Adult Salmon Returns to Columbia River
(Millions)
20
15
10
5
0
1860
1880
1900
1920
1940
1960
1980
199
Bonneville Dam
Lower Granite Dam

TABLE 20

YEARLY TOTALS OF SALMONIDS COUNTED OVER BONNEVILLE DAM

1938 - 1997

YEAR	CHINOOK*	STEELHEAD	SOCKEYE	COHO*	CHUM	PINK	TOTAL SALMONID
1938	271,799	107,003	75,040	15,185	2,117		471,144
1939	286,189	122,032	73,382	14,383	1,168		497,154
1940	391,587	185,174	148,807	11,917	1,729		739,214
1941	461,443	118,089	65,741	17,911	5,269	4	668,457
1942	401,942	151,800	55,464	12,402	1,865	11	623,484
1943	313,123	92,133	39,845	2,547	788		448,436
1944	240,764	100,518	15,072	4,207	954	1	361,516
1945	297,478	120,133	9,501	790	728	1	428,631
1946	446,052	142,807	74,376	3,898	1,178	2	668,313
1947	480,377	135,444	171,139	11,174	199	3	798,336
1948	419,555	139,062	131,541	4,081	3,636	2	697,877
1949	277,697	119,285	51,444	1,004	2,028	6	451,464
1950	357,375	114,087	77,993	10,151	1,069	8	560,683
1951	331,788	140,689	169,428	5,201	1,044	7	648,157
1952	420,879	260,990	184,645	7,768	1,505	9	875,796
1953	332,479	223,914	235,215	13,018	1,728	10	806,364
1954	320,947	176,260	130,107	4,062	1,569	4	632,949
1955	359,853	198,411	237,748	3,725	318	9	800,064
1956	300,917	131,116	156,418	6,127	693	4	595,275
1957	403,286	139,183	82,915	4,675	569	12	630,640
1958	426,419	131,437	122,389	3,673	455	6	684,379
1959	345,028	129,026	86,560	2,695	906	22	564,237
1960	256,049	113,676	59,713	3,268	1,026		433,732
1961	281,980	139,719	17,111	3,456	896	12	443,174
1962	286,625	164,025	28,179	14,788	1,013	27	494,657
1963	278,560	129,418	60,319	12,658	739	34	481,728
1964	344,422	117,252	99,856	53,602	632	45	615,809
1965	317,957	166,453	55,125	76,032	496	64	616,127
1966	340,111	143,661	156,661	71,891	872	58	713,254
1967	366,237	121,872	144,158	96,488	352	50	729,157
1968	341,154	106,974	108,207	63,488	79	21	619,923
1969	507,543	140,782	59,636	49,378	143	86	757,568
1970	384,780	113,510	70,762	80,116	209	150	649,527
1971	405,702	193,966	87,447	75,989	29	176	763,309
1972	394,456	185,886	56,323	65,932	1	51	702,649
1973	398,635	157,823	58,979	54,609	43	12	670,101
1974	366,759	137,054	43,837	60,955	23	2	608,630
1975	425,566	85,540	58,212	58,307	11	309	627,945
1976	507,773	124,177	43,611	53,150	11	2	728,724
1977	366,657	193,437	99,829	19,408	17		679,348
1978	394,600	104,431	18,436	52,590	28		570,085
1979	276,306	113,979	52,628	45,328	1	23	488,265
1980	245,518	129,254	58,882	22,052	44		455,750
1981	285,650	159,270	56,037	30,510	4	20	531,491
1982	322,809	157,640	50,219	73,832	12		604,512
1983	244,346	218,439	100,545	15,173	50	52	578,605
1984	324,425	315,560	152,541	29,487	64	8	822,085
1985	463,873	343,987	166,340	56,857	97	147	1,031,301
1986	570,881	379,891	58,123	130,853	77	23	1,139,848
1987	547,494	303,081	116,993	27,635	147	20	995,370
1988	494,025	279,072	79,714	39,620	60	6	892,497
1989	416,117	287,798	41,884	39,281	16	12	785,108
1990	340,990	183,027	49,581	24,845	26		598,469
1991	274,622	274,545	76,481	64,057	5	550	690,260
1992	256,299	314,975	84,992	18,126	39	24	674,455
1993	277,657	188,386	80,178	11,732	17	15	557,985
1994	243,450	161,978	12,678	22,794	26	5	440,931
1995	240,050	202,448	8,774	12,034	30	36	463,372
1996	296,635	205,213	30,252	18,747	22	1	550,870
1997	387,088	258,385	47,008	27,267	47	64	719,859
Total	21,360,778	10,295,177	5,045,021	1,836,929	38,919	2,226	38,579,050
10-Year Average	322,693	235,583	51,154	27,850	29	79	637,381

*Jacks included

TABLE 121

YEARLY TOTALS OF SALMONIDS COUNTED OVER ICE HARBOR DAM
1962 - 1997

YEAR	CHINOOK*	STEELHEAD	SOCKEYE	COHO*	TOTALS*
1962	94,301	115,796	38	3,207	213,342
1963	61,190	74,539	1,118	1,933	138,780
1964	60,097	58,860	1,276	2,071	122,304
1965	39,233	62,873	317	320	102,743
1966	75,882	65,798	278	878	142,836
1967	84,930	44,205	717	3,770	133,622
1968	98,681	82,383	1,165	6,227	188,456
1969	100,514	63,889	745	5,316	170,464
1970	77,698	53,870	797	3,636	136,001
1971	70,248	67,029	532	2,969	140,778
1972	82,632	63,593	363	2,522	149,110
1973	81,821	38,311	233	2,443	122,808
1974	32,444	12,528	204	1,334	46,510
1975	31,686	16,218	243	1,559	49,706
1976	36,556	23,885	771	1,991	63,203
1977	56,514	54,820	582	1,561	113,477
1978	61,352	27,142	86	652	89,232
1979	13,929	23,117	30	398	37,474
1980	14,717	50,221	36	58	65,032
1981	22,092	41,290	142	82	63,606
1982	22,646	73,405	174	348	96,573
1983	20,259	88,475	216	465	109,415
1984	17,757	94,030	105	22	111,914
1985	47,981	128,481	24	10	176,496
1986	52,615	144,292	20		196,927
1987	47,477	74,491	13		121,981
1988	48,066	99,714	22		147,802
1989	27,234	151,101	4		178,339
1990	31,841	54,758	1	1	86,601
1991	23,175	123,762	9	1	146,947
1992	36,021	160,614	33		196,668
1993	34,991	73,107	17		108,115
1994	7,577	51,704		1	59,282
1995	7,990	92,026	5	4	100,025
1996	16,419	100,805	1		117,225
1997	55,412	103,830	15	128	159,385
Totals	1,693,978	2,654,962	10,332	43,907	4,403,179
10-Year Average	28,873	101,142	12		130,039

*Jacks included

[From the Oregonian, October 1, 1998]

A TERN FOR THE WORSE

RICE ISLAND BIRDS GOBBLE UP MORE JUVENILE SALMON THAN THE CORPS OF ENGINEERS MOVES AROUND DAMS EACH YEAR

They're tiny next to the great concrete dams of the Columbia and Snake Rivers. Their harsh "kraa" sound is no match for the mighty roar of the dams' electric turbines. Northwest policy types don't convene high-toned gatherings to debate whether they should be removed in order to save the endangered salmon. But the gull-like Caspian tern that makes its home on Rice Island in the Columbia River may be inch for inch, a greater threat to Northwest salmon than the region's man-made dams.

And, thanks to Oregon Rep. Bob Smith these salmon munching devils may soon be receiving the attention they deserve.

The Second Congressional District lawmaker and House Agriculture Committee chairman has had the sanity to develop a near obsession over this maddening reality: The Pacific Northwest is now debating proposals to breach or draw down dams on the Columbia and Snake—with the attendant economic consequences to the re-

gion's industries and communities—in order to protect endangered salmon while Rice Island's Caspian terns gobble up 6 to 20 million salmon smolts a year.

Rice Island is at the mouth of the Columbia, where salt water and fresh water mix. Salmon smolts pause there, getting used to the sea water before heading to the ocean.

Dams and electric production and irrigation pumps, it seems, are not the only salmon-unfriendly things on the Columbia. Before anybody disrupts these vast human enterprises, we should combat all animal obstacles to the Northwest's signature fish.

And now a little context. Remember the 6 to 20 million salmon smolts that the terns snapped up? As Smith and other Northwest Congressmen said in a recent letter to the U.S. Fish and Wildlife Service that's more smolts than the Army Corps of Engineers transported around the dams of the Columbia and Snake in all of 1997.

Indeed, the lawmakers noted that a National Marine Fisheries Service study funded by the Bonneville Power Administration and the Corps found these astonishing preliminary results for 1997: Caspian terns, cormorants and gulls consumed between 20 percent to 50 percent of all the salmon smolts entering the Lower Columbia River.

All this "avian predation" as the region's electric rate payers and the nation's taxpayers are dishing out funds—not chicken feed, you can be sure—to make life less nasty, brutish and short for salmon in the Columbia River and its tributaries.

Question: How are we ever to judge the effectiveness of the costly salmon recovery programs upstream when the Rice Island terns are feasting on the tiny fruits of these programs downstream?

"Hundreds of millions of dollars are spent every year on the Columbia River salmon mitigation program, a good portion of which is used to increase smolt survival past the river's dams," the lawmakers wrote to Anne Badgley, regional director of the U.S. Fish and Wildlife Service. "It now looks like a significant amount of that money is being used to feed the bird colonies that nest along the Columbia River."

Feed them quite nicely, it seems.

The Congressmen aren't advocating killing off Rice Island's Caspian terns. But they do think moving the terns off Rice Island by next spring would be a great start. How? By using nonlethal means—say, other animals or humans to harass these birds during their 2-week nesting period. In addition, the lawmakers also would like to see a longer term, more comprehensive effort to combat "avian predation on protected salmon."

This all sounds swell, but leads to another question. Given all the millions we've spent on managers who are supposed to make the world safer for salmon, given the years we've talked of the salmon crisis and given the fact that some are now seriously chatting up taking out dams, why does it take a group of Congressmen to get action?

The U.S. Fish and Wildlife Service—the agency responsible for protecting these birds under the Migratory Bird Treaty Act—has signed a letter with other agencies vowing to address the "avian predation" on salmon smolts in the Columbia River. Bravo. But a Smith aide points put that the Fish and Wildlife Service signed on just 3 days before Smith and congressional crew sent their letter and after months of "hemming and hawing."

Now the bipartisan contingent of Congressmen will be looking for specific action, short and long term. If they don't see some, they promise a legislative fix.

Bravo. Any more delay is for the birds.

[From The Oregonian, October 6, 1998]

BIRDS ONE OF MANY THREATS TO SALMON SURVIVAL

(By Thomas J. Dwyer, Deputy Regional Director, U.S. Fish and Wildlife Service)

In his column, David Reinhard suggests that Caspian terns may be a bigger cause of Columbia River Basin salmon declines than the region's man-made dams. While the U.S. Fish and Wildlife Service agrees that bird predation on juvenile salmon may be a problem, and we are working with other Federal agencies to address it, the significance of this natural predation to wild salmon is unclear.

The potential losses of juvenile salmon to such predation must be considered along with the many other sources of mortality that salmon encounter. Preventing Caspian terns from eating young salmon should not be seized upon as the silver bullet that will restore wild salmon and save the region from addressing larger, more challenging causes of salmon decline, such as dams and habitat loss.

As many as 200 million salmon smolts head downriver in the Columbia Basin each year, most of them hatchery fish. A very high percentage of the smolts die before they reach the estuary where the seabirds live. Given this, we believe other mortality factors more significantly limit salmon recovery in comparison to bird predation. While we are cooperating to address the predation issue, focusing salmon recovery efforts on bird predation control may lead to actions that do not effectively address the immediate problem of smolt survival or the ultimate goal of wild salmon recovery.

A 1997 study indicated that Caspian terns nesting on Rice Island near the mouth of the Columbia may consume 3 percent to 12 percent of all salmon smolts produced in the basin each year, as opposed to the 20 percent to 50 percent cited by Reinhard. Although the number of federally protected wild salmon consumed by the birds is unknown, hatchery fish appear to feed closer to the surface and do not effectively avoid predation, making them more susceptible to predation than wild fish. Research also indicates that salmon smolts that have been transported by barge or truck, and delayed or stressed by passing through dams, are less ready to enter salt water, and therefore are weaker and more vulnerable to predation when they enter the estuary.

The Fish and Wildlife Service—responsible for protecting terns—has participated since last spring in a Federal working group to examine the effects of tern predation on salmon smolts. Despite Reinhard's allegations, we have not been dragging our feet as a Federal agency to address this problem. The working group is developing a plan to move the birds from Rice Island to East Sand Island, closer to the Pacific Ocean, using a combination of non lethal strategies such as habitat enhancement, tern decoys and tapes of calling terns to lure the birds lo the other island. Preliminary research indicates that terns nesting on East Sand Island will have a wider variety of prey and subsequently eat fewer salmon smolts.

While this short-term effort is appropriate, it does not take the place of a long-term, comprehensive strategy for salmon recovery that addresses all threats to salmon survival. Management of bird predation should be considered as one component of a comprehensive strategy to recover federally protected salmon populations. Continued emphasis on modifying hatchery practices, hydropower operations, barging schedules and releases, and improving natural habitat will continue to be critical to the recovery of wild salmon.

LETTER FROM FEDERAL INTERAGENCY GROUP

To Caspian Tern Working Group:

The National Marine Fisheries Service (NMFS), U.S. Army Corps of Engineers (Corps), U. S. Fish and Wildlife Service (FWS) are committed to working together to recover critically depressed salmonids in the Columbia River Basin. A number of naturally reproducing anadromous fish populations in the Columbia River Basin are now listed or proposed for listing under the Endangered Species Act. The NMFS has the principal responsibility for managing recovery of these listed salmonids, while the Corps has responsibility far maintaining the Columbia River navigation channel and the FWS has responsibility for protecting birds.

As the agencies have invested recovery of listed species and the mitigation for lost habitat, numbers of avian predators feeding on juvenile salmonids in the migration corridor have increased. In addition to the major efforts under way to enhance habitat, restrict harvest, reform fish hatchery management, improve fish passage through the hydropower system, and adjust water management, we believe that it is important to address other factors that affect salmonid survival, such as avian predation.

We, therefore, request that the Caspian Tern Working Group (CTWG) immediately: (1) complete development of a short-term strategy for reducing avian predation on listed salmonids in the Lower Columbia River estuary during the 1999 outmigration, (2) develop a monitoring and evaluation plan to determine whether the short-term goals are met and whether future actions are necessary, (3) complete the required environmental documentation, and (4) develop a budget for each action necessary to implement the short-term strategy so that each agency can make its decision on resource commitments for this effort.

In order to assure completion of these tasks, NMFS will provide leadership for this effort and $20,000 in current year funding to prepare an Environmental Assessment. The Corps will prepare the environmental documentation and, as appropriate and subject to available funding, complete necessary site work on East Sand Island. The FWS will provide technical assistance in regards to compliance with the Migratory Bird Treaty Act and the 1999 tern relocation effort. We strongly urge the

CTWG to complete its assignment in a timely manner that ensures implementation of the short-term efforts before the 1999 nesting season.

In addition to the short-term efforts, the agencies will continue to develop an appropriate long-term strategy to deal with bird predation on listed salmonids. An appropriate strategy must address, but not be limited to, (1) development of scientific information to evaluate the impact of predation on listed salmonids, (2) the ecological importance of waterbird colonies in the Columbia River estuary, and (a) the effects of ongoing human activities such as hydropower operation, channel maintenance, etc. as part of any proposed action. The goal of this effort should be the development of a long-term adaptive plan for reducing avian predation on listed salmonids in the Columbia River estuary.

The Federal agencies remain committed to participating in the development of a comprehensive recovery strategy for listed salmonids that address predation as well as habitat loss and degredation, hydropower system operation, hatchery management, and harvest regulation.

Sincerely,

ERIC T. MOGREN, *Colonel,*
Corps of Engineers.

ANNE BADGLEY, *Regional Director,*
U.S. Fish and Wildlife Service.

WILLIAM STELLE, JR., *Regional Administrator,*
National Marine Fisheries Service.

LETTER FROM THE FISH AND WILDLIFE SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE,
Portland, Oregon, October 7, 1998.

HON. DIRK KEMPTHORNE,
U.S. Senate,
Boise, ID 83702.

DEAR SENATOR KEMPTHORNE: Thank you for your letter concerning avian predation on Columbia River salmon smolts. We appreciate the opportunity to provide you with information on this complex issue.

The Fish and Wildlife Service (Service) is committed to working with the National Marine Fisheries Service (NMFS), which is the lead agency for salmon recovery, to ensure the continued survival of threatened and endangered Columbia River salmon. Although avian predation may be one factor affecting these listed species, we believe that it should not be considered in isolation from the broader context of other potentially more significant sources of smolt mortality such as dams, habitat loss and degradation, harvest, competition with hatchery reared fish, fish transportation, and fluctuating ocean conditions. The Service continues to assist NMFS and other agencies to address many of these factors. Since last spring we have been actively working to resolve the unanswered questions concerning the role of avian predation on salmon smolt survival. This letter summarizes efforts to address this issue undertaken to date and describes future plans.

Currently, more than 10,000 nesting pairs of Caspian terns breed on Rice Island in the Columbia River estuary. It is the largest known Caspian tern colony in North America and perhaps the largest colony in the world. The birds began nesting on Rice Island in 1987. Rice Island was created by the Army Corps of Engineers (Corps) in 1962 for the deposit of navigation channel dredge spoils. The island is owned by the States of Oregon and Washington. In 1973, the Service began managing Rice Island as part of the National Wildlife Refuge System under an agreement with the State of Oregon. That lease expired in 1994.

In 1995, the NMFS issued a biological opinion to the Corps on the operation of the Federal Columbia River power system that directed the Corps to conduct studies on Caspian tern predation on juvenile salmonids in the Columbia River. Beginning in 1957, the Corps and the Bonneville Power Administration (BPA) fielded a study conducted by Oregon State University and the Columbia River Inter-Tribal Fish Commission. The first year of this 3-year study has been completed, and the researchers have stated that at least 3 years of data will be needed to accurately measure avian predation on juvenile salmon. Additional work may be necessary to assess the impact of birds on listed stocks.

The first year's report for the avian predation study found that the Caspian terns nesting on Rice Island consumed approximately 6 to 2 million smolts. Clearly, this

is a wide range but indicates that avian predation may account for about 3 to 12 percent of the hatchery and wild smolts produced in the basin. Although the percentage of endangered or threatened listed fish consumed by terns is unknown, hatchery-reared fish appear to be more susceptible to predation than wild fish. For instance, the higher vulnerability of hatchery smolts to tern predation could be expected as a product of rearing practices that condition young salmon to forage at the surface and otherwise weaken predator avoidance behaviors. Research also indicates that salmon smolts transported by barge or truck, and delayed or stressed by passing through dams, may be subject to higher rates of predation when they enter the estuary. Research is also needed to evaluate the assumption that the fish lost to bird predation would have survived to go into the ocean and return.

As a result of preliminary information from this study, the NMFS, Corps, and Service established a multi-disciplinary team to consider potential management options for reducing avian predation on salmonid smolts while continuing data collection during the 1998 season. In a May 6, 1998 letter to the NMFS and Corps, the Service encouraged development of this interagency team. The Caspian Tern Working Group was established to address these issues and has been meeting regularly since last spring. Representatives from the Corps, NMFS, Service, BPA, USDA Wildlife Services, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Columbia River Inter-Tribal Fish Commission, and the researchers participate in the Caspian Tern Working Group meetings.

The working group has developed a proposal to relocate the terns from Rice Island to East Sand Island, an island closer to the Pacific Ocean. during the 1999 breeding season. This process will use a combination of non-lethal strategies such as habitat enhancement on East Sand Island, tern decoys and tapes of calling terns to lure the birds to East Sand Island, and possibly habitat modification on Rice Island. Preliminary research indicates that terns nesting on Fast Sand Island will have a wider variety of prey resources and may subsequently reduce their consumption of salmon smolts. The Corps is in the process of drafting an Environmental Assessment to address the activities associated with relocating the terns. In addition, the working group will develop a monitoring plan and a budget for the proposed management actions. The actions were reconfirmed in a September 22, 1998 letter to the Caspian Tem Working Group and signed by the Service, Corps, and NMFS.

The Service recognizes the importance of salmon recovery efforts in the Columbia Basin. We are a continuing participant in discussions on salmon recovery and will continue to play an advisory role with respect to avian predation. The NMFS has the principal responsibility for managing recovery of listed anadromous salmonids, the Corps has responsibility for operating the Columbia River power system and maintaining the Columbia River navigation channel, and USDA Wildliic Services provides expertise in managing problems caused by wildlife. Other organizations that may participate in this effort include the States of Oregon and Washington that own the islands and the Columbia River Inter-Tribal Fish Commission that represent the anadromous fish interests of the Columbia River treaty Tribes.

Although the Service acknowledges the importance of hatchery-reared fish in the region, our primary focus is on actions that may benefit threatened and endangered wild salmon. We recognize the importance of every wild smolt in the Columbia River to the survival of the endangered salmon populations. For example, Snake River chinook mortality is reported to be between 56 and 70 percent prior to reaching the estuary where the terns nest. Mortality factors include impeded passage from dams and other waterway modifications; loss and degradation of spawning, rearing, and feeding habitat; harvest activities; conflicts with hatchery-reared fish; compromised health from transportation practices; and fluctuating ocean conditions. As a result of these and other factors, less than 1 percent of juvenile salmon survive to adulthood. Because of the large percentage of juvenile salmon lost before reaching the estuary and the large mortality occurring after they leave the estuary, we believe that other mortality factors more significantly limit salmon recovery in comparison to avian predation.

In summary, the Service has actively supported the NMFS's leadership on salmon recovery and will continue to do so. Evaluation of avian predation is only one of the many areas in which NMFS is attempting to address recovery of listed salmonids. There remain many important unanswered questions about the extent and effect of avian predation on wild salmon. We encourage development of a long-term strategy for salmon recovery that addresses all the mortality factors. We appreciate your interest in this issue and will work with the NMFS and Corps to keep you informed. Should you have any further questions, please do not hesitate to contact me or Carol Schuler, Deputy State Supervisor, Oregon State Office, at (503/231–6179).

Sincerely,

THOMAS DWYER, *Acting Regional Director.*

LETTER FROM MEMBERS OF CONGRESS TO THE FISH AND WILDLIFE SERVICE

CONGRESS OF THE UNITED STATES,
September 24, 1998.

ANNE BADGLEY,
Regional Director, Region I,
U.S. Fish and Wildlife Service,
Portland, Oregon 97232.

DEAR MS. BADGLEY: We are very concerned with the extent of salmon smolt mortality due to avian predation in the Columbia River. In particular, we are concerned with predation by the Caspian tern population nesting on Rice Island. While regional study results are preliminary, they suggest that avian predation in the lower Columbia River on salmon smolts, including threatened and endangered salmon, is significant. Draft results for the 1997 salmon migratory season show that between 20–50 percent of all salmon smolts entering the Lower Columbia River estuary are consumed by Caspian terns, cormorants, and gulls. It is estimated that the adult Caspian tern population on Rice Island alone consumed from 6 to 20 million smolts. That is more salmon smolts than the Corps of Engineers transported around dams in the Columbia and Snake River during the same year.

Based on the preliminary results of the study, it is clear that action must be taken to reduce avian predation on salmon smolts. The regional electric ratepayers, and U.S taxpayers cannot continue to fund salmon mitigation efforts along the Columbia River and its tributaries without also managing the bird colonies that prey on the young salmon. Hundreds of millions of dollars are spent every year oil the Columbia River salmon mitigation programs, a good portion of which is used to increase smolt survival past the river's dams. It now looks like a significant amount of that money is being used to feed the bird colonies that nest along the Columbia River.

In light of the significant proportion of smolts the Caspian terns at Rice Island are estimated to have consumed, relocating the terns from Rice Island next spring would be a good start toward managing the problem. In the longer term, a more comprehensive effort to address avian predation on protected salmon is certainly justified. It is our understanding that your agency reached an agreement with other Federal agencies to address avian predation on salmon in the Columbia River. This is very encouraging. The importance of cooperation among the Federal agencies with jurisdiction over this issue cannot be over emphasized.

In light of your responsibility to protect these birds under the Migratory Bird Treaty Act and the conflict this present for protection of listed salmon, we would like a detailed explanation of the steps your agency is taking to prevent predation by the terns during next spring's migratory season. This explanation should include an indication of the amounts of funding your agency will spend to carry out this action. In addition, we would like a description of the steps your agency is taking to develop and implement a long-term management program for all the avian populations preying on the region's salmon runs. Finally, your explanation should address continued monitoring and evaluation of this situation.

We are confident that with cooperation among the Federal and state agencies, salmon smolt mortality due to avian predation can be significantly reduced. Thank you for your attention to this matter. We look forward to working with you on this issue and anticipate your timely response to our questions.

Sincerely,

ROBERT F. (BOB) SMITH,
Member of Congress.

DOC HASTINGS,
Member of Congress.

JACK METCALF,
Member of Congress.

GEORGE NETHERCUTT,
Member of Congress.

ADAM SMITH,
Member of Congress.

MIKE CRAPO,
Member of Congress.

LINDA SMITH,
Member of Congress.

HELEN CHENOWETH,
Member of Congress.

NORM DICKS,
Member of Congress.

RICK WHITE,
Member of Congress.

LETTER FROM THE FISH AND WILDLIFE SERVICE

U.S. DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE,
Portland, Oregon, October 7, 1998.

HON. ROBERT SMITH,
Medford, Oregon 97504.

DEAR CONGRESSMAN SMITH: Thank you for your letter concerning avian predation on Columbia River salmon smolts. We appreciate the opportunity to provide you with information on this complex issue.

The Fish and Wildlife Service (Service) is committed to working with the National Marine Fisheries Service (NMFS), which is the lead agency for salmon recovery, to ensure the continued survival of threatened and endangered Columbia River salmon. Although avian predation may be one factor affecting these listed species, we believe that it should not be considered in isolation from the broader context of other potentially more significant sources of smolt mortality such as dams, habitat loss and degradation, harvest, competition faith hatchery reared fish, fish transportation, and fluctuating ocean conditions. The Service continues to assist NMFS and other agencies to address many of these factors. Since last spring we have been actively working to resolve the unanswered questions concerning the role of avian predation on salmon smolt survival This letter summarizes efforts to address this issue undertaken to date and describes future plans.

Currently, more than 10,000 nesting pairs of Caspian terns breed on Rice Island in the Columbia River estuary. It is the largest known Caspian tern colony in North America and perhaps the largest colony in the world. The birds began nesting on Rice Island in 1987. Rice Island was created by the Army Corps of Engineers (Corps) in 1962 for the deposit of navigation channel dredge spoils. The island is owned by the States of Oregon and Washington. In 1973, the Service began managing Rice Island as past of the National Wildlife Refuge System under art agreement with the State of Oregon. That lease expired in 1994.

In 1995, the NMFS issued a biological opinion to the Corps on the operation of the Federal Columbia River power system that directed the Corps to conduct studies on Caspian tern predation on juvenile salmonids in the Columbia River. Beginning in 1997, the Corps and the Bonneville Power Administration (BPA) fielded a study conducted by Oregon State University and the Columbia River Inter-Tribal Fish Commission. The first year of this 3-year study has been completed, and the researchers have stated that at least 3 years of data will be needed to accurately measure avian predation on juvenile salmon. Additional work may be necessary to assess the impact of birds on listed stocks.

The first year's report for the avian predation study found that the Caspian terns nesting on Rice Island consumed approximately 6 to 25 million smolts. Clearly, this is a wide range but indicates that avian predation may account for about 3 to 12 percent of the hatchery and wild smolts produced in the basin. Although the percentage of endangered or threatened listed fish consumed by terns is unknown, hatchery reared fish appear to be more susceptible to predation than wild fish. For instance, the higher vulnerability of hatchery smolts to tern predation could be expected as a product of rearing practices that condition young salmon to forage at the surface and overwise weaken predator avoidance behaviors. Research also indicates that salmon smolts transported by barge or truck, and delayed or stressed by passing through dams, may be subject to higher rates of predation when they enter

the estuary. Research is also needed to evaluate the assumption that the fish lost to bird predation would have survived to go into the ocean and return.

As a result of preliminary information from this study, the NMFS, Corps, and Service established a multi-disciplinary team to consider potential management options for reducing avian predation on salmonid smolts while continuing data collection during the 1998 season. In a May 6, 1998 letter to the NMFS and Corps, the Service encouraged development of this interagency team. The Caspian Tem Working Group was established to address these issues and has been meeting regularly since last spring. Representatives from the Corps, NUTS, Service BPA, USDA Wildlife Services, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Columbia River Inter-Tribal Fish Commission, and the researchers participate in the Caspian Tern Working Group meetings.

The working group has developed a proposal to relocate the terns from Rice Island to East Sand Island, an island closer to the Pacific Ocean, during the 1999 breeding season. This process will use a combination of non-lethal strategies such as habitat enhancement on East Sand Island, tern decoys and tapes of calling terns to lure the birds to East Sand Island, and possibly habitat modification on Rice Island. Preliminary research indicates that terns nesting on East Sand Island will have a wider variety of prey resources and may subsequently reduce Weir consumption of salmon smolts. The Corps is in the process of drafting an Environmental Assessment to address the activities associated with relocating the terns. In addition, the working group will develop a monitoring plan and a budget for the proposed management actions. The actions were reconfirmed in a September 22, 1998 letter to the Caspian Tem Working Group and signed by the Service, Corps, and NMFS.

The Service recognizes the importance of salmon recovery efforts in the Colombia Basin. We are a continuing participant in discussions on salmon recovery and will continue to play an advisory role with respect to avian predation. The NMFS has the principal responsibility for managing recovery of listed anadromous salmonids, the Corps has responsibility for operating the Columbia River power system and maintaining the Columbia River navigation channel, and USDA Wildlife Services provides expertise in managing problems caused by wildlife. Over organizations that may participate in this effort include the States of Oregon and Washington that own the islands and the Columbia River Inter-Tribal Fish Commission that represent the anadromous fish interests of the Columbia River treaty Tribes.

Although the Service acknowledges the importance of hatchery reared fish in the region, our primary focus is on actions that may benefit threatened and endangered wild salmon. We recognize the importance of every wild small in the Columbia River to the survival of the endangered salmon populations. For example, Snake River chinook mortality is reported to be between 56 and 70 percent prior to reaching the estuary where the terns nest. Mortality factors include impeded passage from dams and other waterway modifications; loss and deflation of spawning, rearing, and feeding habitat; harvest activities, conflicts with hatchery reared fish, compromised health from transportation practices; and fluctuating ocean conditions. As a result of these and other factors, less than 1 percent of juvenile salmon survive to adulthood. Because of the large percentage juvenile salmon lost before reaching Me en and the large mortality occurring after they leave the estuary, we believe that other mortality factors more significantly limit salmon recovery in comparison to avian predation.

In summary, the Service has actively supported the NMFS's leadership on salmon recovery and will continue to do so. Evaluation of avian predation is only one of the many areas in which NMFS is attempting to address recovery of listed salmonids. There remain many important unanswered questions about the extent and effect of avian predation on wild salmon. We encourage development of a long-term strategy for salmon recovery that addresses 1 the mortality factors. We appreciate your interest in this issue and vail work with the NMFS and Corps to keep you informed. Should you have any further questions, please do not hesitate to contact me or Carol Schuler, Deputy State Supervisor, Oregon State Office, at (5031231–6179).

Sincerely,

THOMAS DWYER, *Acting Regional Director.*

LETTER FROM THE NORTHSIDE CANAL COMPANY

July 22, 1998.

MR. WILL STELLE, JR.,
Northwest Regional Administrator,
National Marine Fisheries Service,
Seattle, WA 98115–0070.

DEAR MR. STELLE: Over the past many years, I have continually identified to NMFS and the Northwest Power Planning Council our concern about the potential significance of harvest and predator mortalities and their effect on the regional recovery programs. Generally, I conclude that these issues continue unabated and probably prevent a successful recovery program. During my preparation of these comments, I also became more keenly aware of the status of the anadromous fish screening program and included some related comments on this issue because of its mortality contributions.

Please find enclosed my latest calculations and conclusions regarding salmonid mortality caused by: (1) fish predation; (2) avian predation; (3) pinnipeds; (4) unscreened diversions; and (5) harvest. These observations are based upon actual regional studies and I believe that they are reliable. If you have information which suggests that any of this data is wrong, or that the abbreviated calculations have been done incorrectly, please provide me with the corrections. In following the progress and reports of PATH, it is apparent that the group's retrospective and prospective analyses have not directly addressed the above mortalities. Specifically, PATH has not addressed the potential for improving salmonid survival by reducing the above-noted mortalities, as part of its determination of "robust" survival and recovery actions.

As stated in my letter to you dated June 30, 1998, those of us that provide water for flow augmentation are fearful that inadequate attention is being given to those obvious causes of mortality which can be addressed with practical solutions. This, coupled with the lack of evidence to justify the current flow augmentation program, deserves NMFS' most serious and immediate attention.

The purpose of this communication is to convey the message that significant mortality causes exist that are feasible to correct, but me not being addressed. We firmly believe that continued avoidance of these issues and continued pursuit of unnecessary, drastic and unproven endeavors will destine the anadromous fish recovery effort to failure, or unreasonably extend its time and cost with no improvements. Simply put, we doubt that the region will accept this scenario without serious, prolonged convict.

Lastly, we wish to remind NMFS that even after the extensive efforts directed to recovery, we calculate the estimated 1998 Snake River spring/summer chinook SAR to be 0.3 to 0.4 percent. Based on the preliminary PIT tagged ocean returnees 1998 (of the 1996 juvenile out-migration class) and the 1998 jack returns, significant future improvements in Idaho's SARs are not anticipated—certainly not near the 2 to 6 percent SAR estimated as necessary for recovery. Obviously, other practical things must be done to achieve success. Accordingly, we have suggested some actions that should have been taken earlier or should be taken now. Even if the enclosed estimates are in error by 50 percent, such suggested actions may result in significantly improved spawner numbers by 100 percent or more.

In the words of a NMFS official quoted at a July 1,1938 meeting in Seattle, "If we have it wrong help us set it right."

Thank you for your consideration.

Sincerely,

DEWITT MOSS, *Director,*
North Side Canal Company and Member, Committee of Nine.

ATTACHMENT

COLUMBIA RIVER PREDATION

Consider the following:

1. The largest double crested cormorant colony in the Columbia River Basin (6,000 nesting pairs) is at East Sand Island in the estuary. Preliminary diet samples suggests that cormorants in the estuary are specializing on juvenile salmonids during some phases of the nesting season. The population has increased 168 percent over the past 5 years.

2. The Caspian tern colony on Rice Island is currently the largest in North America (over 8,000 nesting pairs) The population has increased 641 percent over the past 12 years. OSU estimates that between 6 to 20 million salmonids were consumed by the Caspian terns at Rice Island in 1997.

Two major gull colonies exist in the Richland, WA area and numbered 35,000 nesting pairs in 1996. In 1986 Ruggerone estimated ring-billed gulls consumed 2 percent of the spring migration of juvenile salmonids below Wanapum Dam; and there exists some 20 dams on the Columbia River and Snake River.

4. There are 8 other "major" water bird colonies on the lower Columbia River.

5. Recovery of smolt tags at colonies of fish-eating birds suggests avian predation cause losses of perhaps as high as 40 percent of smolts that reach the estuary in some years (OSU report).

6. ". . . avian predation may be a prominent factor limiting, recovery in the Columbia River."

Therefore, if one assumes the following:

Calculation	
Source	Smolts Consumed
Caspian terns—Rice Island	15 million annually
8 other colonies at 25 percent rate of consumption	30 million annually
Gulls—Wanapum and 20 dams (estimate)	1 million annually
Estimated Smolt Mortality	46 million annually

Below Bonneville, estimates of smolts in the river can range between 100 million and 180 million. 46 million divided by 120 million (avg)—38 percent smolt mortality.

As compared to paragraph 5 above, estimate of 40 percent mortality which calculates to: 0.40 X 120 million = 48 million smolt mortality.

Again, one must query whether this avian predation is a major contributor to the delayed or "extra" mortality identified by PATH? It is probable that hatchery salmonids are more susceptible to avian predation because of their surface feeding habits and brighter coloring. Again, the juvenile salmon mortality can be calculated to be very significant from avian predation.

Reduction of the avian predation effects to migrating juvenile salmonids could result in increased retiming adult salmon of 500,000 to 100,000 per year, similar to the numbers generated by reducing the Columbia River piscivorous predators. Repeating, reducing juvenile salmonid predation by avians could be a logical and significant recovery action, achievable and not disruptive to the region's economies and societal values.

COLUMBIA RIVER JUVENILE SALMONOID LOSSES BY PISCIVOROUS PREDATION

During 1983–1986, an extensive 3-year study was performed[1] in John Day Reservoir with an objective "to estimate the number of juvenile salmon and steelhead lost to resident fish predators in an entire Columbia River reservoir."

It was estimated the mean annual loss during April to August was 2.7 million juvenile salmonids (range 1.9 to 3.3 million). Northern squawfish were responsible for 78 percent of the total loss, walleyes (13 percent), and smallmouth bass for 9 percent. Fish predators consumed 14 percent of all juvenile salmonids that entered the reservoir. The predator mortality was dependent upon month and water temperature with ranges of 7 percent in June to 61 percent in August. Small sub-yearling chinook are the main prey during the late summer months.

A predation index in the Lower and Middle Columbia River and in the Lower Snake River was reported[2] and determined the predation index downstream from Bonneville Dam in the estuary was about 7 to 10 times that of the mean 1990–1993 index for John Day Reservoir. The population estimates of squawfish from John Day Reservoir through the estuary is 1,351,000 (> 253 mm) and another 381,000 walleye, bass and catfish predators for a total of 1,732,000 predators. McNary through Lower Granite predation indexes generally range about one half that of John Day, but the reaches are 3 times longer and therefore it is conservative to conclude another 100–2,000,000 fish predators exist beyond the 1,732,000 noted above. Squawfish populations of 100–160,000 have been reported in each of the Ice Harbor and Lower Granite regions.

Survival of juveniles was insensitive to . . . the duration of prey passage, residence time, . . . and flow, yet these are important functions of the FLUSH Code! With the bias of FLUSH favoring mortality as a function of time in transit of a juve-

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[1] Estimated Loss of Juvenile Salmonoids to Predation by Northern Squawfish, Walleyes, and Smallmouth Bass in John Day Reservoir, Columbia River: Transactions Of the American Fisheries Society, 1991. Reiman, Beamesderfer, Vigg, Poe, et al.

[2] Index of Predation on Juvenile Salmonoids by Northern Squawfish in the Lower and Middle Columbia River and in the Lower Snake River: Transactions of the American Fisheries Society, 1995: Ward, Petersen and Loch.

nile, this code may incorrectly or inadequately imply flow augmentation is a benefit, when it is not. Because of the sensitivity of prey density, transportation benefits may be offset by significantly higher mortality of fish left in river, (Just food for thought.)

CALCULATIONS FOR SMOLT MORTALITY DUE TO PISCIVOROUS PREDATORS

a. In 1987 (avg.) 2.7 million salmonids consumed in John Day Reservoir.
b. This equals 36,486 juveniles consumed per mile, or 22,000 juveniles consumed per km.
c. Predators increased by 20 percent per year during the 3-year study.
d. Assume predator mortality and predator removal (reported to be 2 percent annually) results a conservative 5 percent annual increase in predator numbers. This results in a 1997 predator consumption of 34,000 smolts per km.
e. Use a predation index averaged over the migration period and for each individual reach of the Columbia Riser and Snake River (use predation index only at Ice Harbor for spring/summer runs) and no Middle Columbia reaches or dams:

Summary Via Index Method

All Fish Predators of Juveniles

Reach	Distance	Smolts Consumed
Bonneville Dam to ocean	233km	33 million
Bonneville Dam to Dalles	70km	3 million
Dalles to John Day	41km	7 million
John Day to McNary	122km	4 million
McNary to Ice Harbor	68km	1 million
Est. Other Reaches		1 million
Annual Total		49 million

SUMMARY VIA PREDATOR POPULATION AND AVERAGE CONSUMPTION RATE

In 1987: Predators consumed 0.14 juveniles per predator (avg), and assume predators increase 5 percent per year.
In 1992 and 1993: Estimated squawfish (> 250 MM) from ocean to John Day Reservoir was 1,351,000.
Calculated 1993 total fish predators were 1,700,000.
Estimated 1997 total fish predators were 2,000,000.
Estimate of 200,000 predators above John Day.
Estimate 150 days (April through August) migration period.
Therefore: 150 X 2,200,000 X 0.14 = 46 million smolts consumed annually.
If one were to take these numbers and use the lower value of 46 million smolts consumed, and further assume we could reduce predation by 50 percent with proper control methods, this would leave 23 million additional smolts to migrate to the ocean. If a 98 percent ocean mortally occurred and harvest was restricted there could be an additional 460,000 adult salmonids return to the Columbia River basin.
Although we have no predation numbers, we further note that between 2 and 4 million shad reside in the Columbia River and are " . . . food competitors and potential predators (avg. size of 3.5 lbs.) of juvenile salmon . . . and delay upstream passage through fish ladders (Chapman et. al., 1991). Perhaps even more important, the abundant shad juveniles may serve as a large food base for piscivorous fishes during the late fall and winter, thus serving to maintain predator populations at high levels (Kaczynski and Palmisano, 1993)."
In summary, piscivorous predation of salmonids is significant by any standard, and the predator population continues to increase. One is stymied to come forward with a more innocuous recovery action that is technically feasible, relatively inexpensive, and does not impact regional economies and societal values. Results could be apparent within a 3-year period.

PINNIPED MORTALITY

The California sea lion population off the west coast of the United States in 1994 was estimated at between 161,000 and 181,000. This population has been increasing at an annual rate of about 5 percent per year since the mid-1970's. The pacific har-

bor seal population for the west coast was 76,000 in 1993–1995. This population has been increasing at an annual rate of 3–7 percent per year since the mid-1970's. Generally 50–60 percent of these populations reside off the Oregon and Washington coasts. Harza reported the Oregon and Washington coastal population of marine mammals has increased from 6,000—1,000 in the 1970's to approximately 50,000 by the mid-1990's. The Northwest Fisheries Science Center and National Marine Fisheries Services reported that "predation by California sea lions and Pacific harbor seals may now constitute an additional factor in salmonid population decline and can effect recovery of depressed salmonid populations in some simulations."

Upwards of 500 sea lions are found in the Columbia River estuary from Astoria to Bonneville Dam, per NMFS. Many of the Washington and Oregon coastal harbor seals feed in the summer in the Columbia River. The SRSRT reported harbor seals in the Columbia River have increased from less than 500 in 1976 to almost 3,500 in 1993. The SRSRT noted that pinniped scarring (damage) of salmonids at Lower Gramte ranged from "2 percent to 70 percent" depending upon the year and species. Recent pinniped damage at Lower Granite has been reported to be in the "25–40 percent" range. Because only one side of the fish is viewed at the dams, this damage is probably under reported. Some have suggested that the salmon mortality due to marine mammals is equal to that due to the combined sport and commercial harvest (Kazcynski and Palmisano, 1993). Harvesting of certain populations (fall chinook) are in the 50 percent range (SRSRT Draft Report).

In 1997, 360,000 spring, summer, and fall chinook and 230,000 steelhead arrived at Bonneville Dam. Assume we harvested 50 percent in the ocean and estuary. Therefore, we would have harvested about 600,000 Columbia River chinook and steelhead.[1] Assume predator direct kill and damaged salmonids that cannot reach their spawning grounds or are too weakened to reproduce approaches 50 percent as proposed by Kaczynski and Palmisano. Then one can conclude that pinniped mortality occurs to approximately 300,000 adult salmonids. Eliminating pinniped mortality and injury could easily result in an additional 300,000 adult spawners, nearly equal the total 1997 chinook count at Bonneville Dam. These numbers do not include mortality of juveniles, which pinnipeds consume. A 1995 British Columbia study reported pinnipeds consuming 7 to 31 percent of the total smolt production in the Puntledge River.

Again, the impacts of removal of pinnipeds does not effect economics or societal values and offers a method to increase adult salmonid spawners by an estimated 50 percent; the results should be apparent within 1 year.

SCREENING

In reviewing the 1997 Annual Fish Screen Oversight Committee Report, we note that needed screening of diversions in Idaho, Oregon, and Washington is not complete—far from it. Yet these devices are simple mechanical structures that divert juvenile salmonids to migratory channels, avoiding a diversion caused mortality. We also note we are spending and have spent hundreds of millions of dollars to improve juvenile fish passage through the reservoir-dam corridor. We are perplexed why such a screening, deficiency exists.

Without getting into details as to why and what, we note the following screen situation for Columbia River Basin Anadromous Fish Diversions:

State	SCREENS		
	Constructed to NMFS Criteria	Existing—Need Upgrade	Diversions Unscreened
Oregon	217	296	85
Washington	92	53	12
Idaho	129	114	274
Totals	438	463	361

[1] This number is probably in the proper range, based on the following: The Pacific Fisheries Management Council projected the west coast 1998 harvest of just chinook salmon to be 905,800 (663,400 Mom commercial and 242,400 from recreational fisheries). The totals are composed of 25,000 spring, 148,400 summer and 716,300 fall chinook, for all of the west coast. The Columbia River portion would be less.

Approximately 65 percent of the diversions do not adequately protect migrating smolts. In 1995, Oregon eliminated the screening requirement, except in extremely limited situations, for diversions less than 30 cfs. From a safe smolt protection aspect of an endangered species, the fact the Mitchell Act was authorized in 1946 to construct safe fish passage screens; BPA, BOR, State(s) and COE funds have been available and spent; it is appalling that this simple mechanical "fix" has not been completed in a timely-needed manner.

Again, if the salmonid smolts diversion entrainment and mortality are significant, and we acknowledge we realistically cannot arrive at a defensible number, this further reduces the number of salmonids for migration. We could be concerned that diversion and mortality, unacknowledged, could obscure analysis of migration mortalities through the system and mistakenly be allocated to flow causes or mortality per roils assignments, when in fact such mortality can be easily and totally avoided. From a prudent management aspect, this is one simple way to remove a variable from the mortality equation to improve and assure proper interpretation of spanning to escapement results.

HARVEST

Steve Mathews, University of Washington, in 1998 notes " . . . up to 80 percent of the fall chinook stocks from the Columbia is harvested, much of it taken at sea" "About half are caught by commercial trollers, 28 percent by sports fisherman and 22 percent by commercial net fishermen." Many sublegal sized fish are hooked, and their hooking mortality approaches 30 percent; " . . . these various calculations and extrapolations indicate that there is substantial incidental catch waste approaching one million dead chinook a year." "If such waste was eliminated, and some of the savings converted to additional spawning escapement, the total catch of chinook salmon in the long term could be increased even more than one million fish per year."

In another recent report describing Snake River fall chinook, abut 2,300 Snake River chinook salmon returned to Bonneville Dam. In approximate terms 1/3 were harvested, 1/3 were lost due to straying or dam passage mortality and 1/3 were allowed to pass Lower Granite to spawn, recognizing that of those passing Lower Granite 25–40 percent had significant pinniped damage, possibly effecting downward the number that actually spawned. We strongly believe harvesting of endangered stocks should be terminated at the mouth and on the main stem Columbia River, until recovery is assured, or at least restricted to tribal fisheries on tributaries with totally healthy populations and/or terminal hatchery locations. Totally eliminating ocean and user harvesting for 1 year or more would rapidly determine the rate of improvement expected from harvest restriction and better define appropriate harvest limits.

To add another opinion to our above recommendations, we call your attention to ex-ISAB member Jack Sanford's first principle of Columbia River anadromous fishery restoration:

1. Harvest Is An Issue

"All harvest must stop until recovery of target stocks . . ."

We also note the State of Idaho's January 3, 1997 comments to NMFS on the proposed listing of Snake River steelhead, namely:

"Existing harvest management in the mainstem of the Columbia River does not adequately consider the conservation needs of wild steelhead and must be reformed."

Since Idaho generally has more steelhead returning than chinook, the above quote is believed applicable to all Idaho salmonids.

We note the following comments offered to NMFS by credible program reviewers regarding harvest:

Upstream: 1995

1) "In the late 1980's, ocean fisheries took about 35 percent of the fish and river catch took 44–63 percent of the in-river run . . . so fisheries took nearly 73 percent of adult recruits . . ."

2) "Incidental deaths of chinook have been estimated at 30–50 percent of the reported catch during the middle 1980's . . ."

3) "Furthermore, the committee does not believe that the sustainability of Pacific Northwest salmon can be achieved without limiting the interceptions of U.S. salmon in Canada and obtaining cooperation of Alaska."

4) "The number of fish returning to spawn (escapements) must be substantially increased . . . increased escapements . . . is necessary for restoring, production . . ."

Return to the River, 1996

1) "Both Bristol Bay, Alaska, and the Fraser River, Canada, support thriving sockeye populations today, because, since implementation of effective harvest management regimes, whenever spawning populations have reached critically low levels, fishing has been reduced, or stopped" . . . "The sacrifice of the harvesters in 1973 led to large returns . . . in the next generation in 1978."

2) "Harvest, both incidental and intentional, . . . is a factor limiting their recovery . . ."

Proposed Recovery Plan For Snake River Salmon

1) "There should be no commercial or recreational fisheries directed at upriver spring or summer chinook in the mainstem Columbia River below its confluence with the Snake River".

2) "First, harvesting limitations combined with a reduction of marine mammal predation and inter-dam losses, are measures that would, if implemented promptly, provide some immediate progress toward recovery, until intermediate and long term measures can be taken and become effective . . . Even if no improvement in upstream passage is implemented, perhaps one half of the fish allowed to escape harvest will make it to the spawning grounds (more, if upstream passage is improved).'

The adult passage losses surely can be reduced to something less than the 30–50 percent now occurring (via barging or in-river transit of juveniles—no trucking—and improved ladders/devices/flows to avoid fallback, etc.).

LETTERS FROM SENATOR KEMPTHORNE

OFFICE OF SENATOR DIRK KEMPTHORNE,
October 5, 1998,

HON. TERRY GARCIA,
Assistant Secretary for Oceans and Atmosphere,
National Oceanic and Atmospheric Administration,
Department of Commerce,
14th Street and Constitution Avenue,
Washington, DC 20230.

DEAR MR. GARCIA: I am writing today to express my concern about the National Marine Fisheries Service's (NMFS) apparent disregard of my requests for information on how decisions are made regarding allowable "take" of threatened and endangered stocks of Pacific salmon and steelhead. The formulation of public policy is best made when the Legislative branch and the Executive branch are equally well informed on the issues.

Specifically, I have asked the NMFS repeatedly over a period of 3 months for the biological opinions on harvest made under Section of the Endangered Species Act. Although they have been repeatedly promised to me, I have not yet received any biological opinion on this subject.

Also, at a meeting with Will Stelle on June 24 of this year, I specifically mentioned my need for this information. I was assured by Will that information on harvest would be forthcoming promptly. Since that meeting, I have received a few pages of data, but hardly the information that I requested.

This matter has become a matter of urgency because I am holding an oversight hearing in the Subcommittee on Drinking Water, Fisheries, and Wildlife of the Senate Environment and Public Works Committee on scientific and engineering issues relating to Columbia/Snake River system salmon recovery. That hearing, to be held Thursday, October 8, will discuss some of the current issues on harvest. I believe the hearing would be much more informative for all concerned if the information requested months ago had been made available in a timely manner.

I had a similar experience with the NMFS last year. In April, I wrote to Mr. Stelle to request information on the biological basis of NMFS decisions on transport of salmon and steelhead in the Columbia/Snake River system. Because my April letter was ignored, I wrote again in June, long after the decision date for the action I was questioning. I have attached both letters for your information.

It appears to me that the NMFS strategy is to ignore me and the stakeholders that I represent until well after decisions on controversial issues have been made.

I would like your assessment of the current situation, and suggestions for prompt provision of information in a timely and effective manner.

Sincerely,

DIRK KEMPTHORNE,
United States Senator.

OFFICE OF SENATOR DIRK KEMPTHORNE,
April 16, 1997.

WILLIAM STELLE,
Administrator, Northwest Region,
National Marine Fisheries Service,
7600 Sand Point Way,
BIN-C15700, Bldg. 1,
Seattle, Washington 98115–0070.

DEAR MR. STELLE: I am writing you about my strong concerns regarding the National Marine Fisheries Service's (NMFS) decision to disregard the consensus proposal on steelhead and salmon migration. It is my understanding that at the recent meeting of the Executive Committee for recovery of Columbia/Snake River salmon and steelhead that a consensus proposal to transport up to 42 percent of Chinook Salmon and 54 percent of Steelhead on alternate days from Lower Granite, Little Goose and Lower Monument Dams was rejected by the National Marine Fisheries Service. Instead, the NMFS adopted daily full transport from the same sites for up to 67 percent of the Chinook and 84 percent of the Steelhead.

Will, If my information is correct, I need to understand the biological basis of this decision. Governor Batt, with the advice of some of the best biologists, water managers, and stakeholders devised a plan for "spreading the risk" between in-river migration and barging. This plan was subjected to a facilitated negotiation process that involved stakeholders from throughout the Columbia/Snake River Basin. The resulting proposal deserved to be considered for its ability to recover two of our regions most important fish species, and for its ability to bring together stakeholders from throughout the basin.

This year we are blessed with abundant water to flush fish down the rivers and to the ocean. We may or may not be so lucky next year. I need to know soon if the NMFS knows of some solid biological reason why we should transport such a high percentage of fish.

Thank you for your attention to this issue. I look forward to your timely reply.

Sincerely,

DIRK KEMPTHORNE,
United States Senator.

OFFICE OF SENATOR DIRK KEMPTHORNE,
June 5, 1997.

WILLIAM STELLE,
Administrator, Northwest Region,
National Marine Fisheries Service,
7600 Sand Point Way,
BIN-C15700, Bldg. 1,
Seattle, Washington 98115–0070.

DEAR MR. STELLE: I am writing today to express once again my concern about the National Marine Fisheries Service's (NMFS) decision to disregard the 1997 consensus proposal on steelhead and salmon migration. And, I must share with you my frustration over your failure to promptly answer my mid-April letter to you.

On April 16 I wrote to you about your decision at the Executive Committee for -recovery of Columbia/Snake River salmon and steelhead to ignore the Idaho consensus proposal on the transport issue. Instead, you adopted daily transport from Salmon River dams for up to 67 percent of the Chinook and 84 percent of the Steelhead. I asked you to explain the biological basis of this decision.

Governor Batt, with the advice of some of the best biologists, water managers, and stakeholders devised a plan for" spreading the risk" between in-river migration and barging. This plan was subjected to a facilitated negotiation process that involved stakeholders from throughout the Columbia/Snake River Basin. The resulting proposal deserved to be considered for its ability to recover two of our regions most important fish species.

Yet, you chose to transport more fish rather than fewer. If there is a good biological reason for your decision, you have failed completely to inform me and other stakeholders who contributed their time and energy to working together toward a common goal. During the time you have failed to respond to my letter, or to my staff inquiries, ever higher numbers of fish have been transported down the Snake and Columbia Rivers. Estimates are that when the spring migration ends later this month, 58 percent of the wild salmon and 68 percent of the wild steelhead will have been barged.

Is it your strategy to ignore me and the stakeholders who worked together to obtain a compromise until the migration season is over? I understand fully that at some point there will be no need to respond at all to my letter or to the others who are concerned about this issue. Frankly, this is only the most recent failure on your part to respond promptly and fully to my inquiries.

I look forward to your timely reply.

Sincerely,

DIRK KEMPTHORNE,
United States Senator.

Senator KEMPTHORNE. In today's first panel—in fact, let me just hold off in the introduction of the first panel and at this point turn to Senator Chafee, again, the Chairman of the Full Environment and Public Works Committee, for any comments that he might have.

OPENING STATEMENT OF HON. JOHN H. CHAFEE, U.S. SENATOR FROM THE STATE OF RHODE ISLAND

Senator CHAFEE. Mr. Chairman, thank you very much.

There are two reasons that I'm here today—one, this is an interesting subject. I had the privilege of visiting this area with you 2 years ago, and it's a fascinating area and very challenging. I think it's so appropriate that you are holding this hearing today, and I would ask, Mr. Chairman, that my statement might be placed in the record.

Senator KEMPTHORNE. Without objection.

[The statement of Senator Chafee follows:]

STATEMENT OF HON. JOHN H. CHAFEE, U.S. SENATOR FROM THE STATE OF RHODE ISLAND

I would like to thank my friend and colleague for calling for this morning's hearing on salmon recovery issues in the Colombia and Snake rivers. Even in the waning days of his Senate career, the Chairman is steadfastly pursuing answers to difficult questions that challenge our efforts to protect our natural resources. It is this tenaciousness that has led to some remarkable achievements during his Senate career, including enactment of the Unfunded Mandates legislation and the Safe Drinking Water reauthorization, and in authoring a bipartisan bill to reauthorize the Endangered Species Act. We will miss him.

Salmon recovery in the Columbia River basin poses some of the greatest challenges that we face in protecting species. If we can save the salmon, we can save any species. Why is the challenge so great? There are several reasons. First, we waited too long in confronting the inevitable reality that these species were going extinct. The Snake River sockeye was not listed under the ESA until there were no more than 10 fish returning to the one remaining spawning ground in Redfish Lake.

Second, the natural life cycle of the salmon is so complicated. They migrate from freshwater to the ocean, traveling hundreds of miles between. They face a multitude of threats as they make this journey. Juveniles contend with competition from introduced species, serve as prey for other native species, and run through a series of eight dams; adults contend with ocean and in-river fishing; and returning spawners must again run the gauntlet of the dams, and facing degrading habitat conditions for breeding.

Third, the political and scientific complications in determining our next steps are so great. Our scientific knowledge of what is best for the salmon still has many gaps. The organizations responsible for coming up with the scientific knowledge, and making the decisions based on that knowledge, involve local governments, state governments, tribal governments, and numerous agencies within the Federal govern-

ment. Many times, each one has a different view. Numerous industries are affected by these decisions. No one group has the answer, and only now are all the groups beginning to work together in finding the answer.

This morning's hearing will give us some insight into some of the issues that need to be addressed in recovering the salmon in the Columbia and Snake rivers. The information that we derive from our witnesses will serve us well in Congress, and I am certain will serve Senator Kempthorne well in his future endeavors. Thank you.

Senator CHAFEE. The other reason, Mr. Chairman, that I am here is that today you are presiding over this subcommittee for the final time this Congress. I just want to take this opportunity to pay tribute to you for the terrific job that you've done in the Environment and Public Works Committee.

When you came to the Senate 6 years ago, you joined this committee, and your life in the Senate has been a tremendously constructive one. Right out of the blocks, you came forward with the unfunded mandates provision that was enacted into law. That in itself was an achievement, but then on this particular committee your work has been on the Safe Drinking Water Act, which, with your leadership, we came forward with a splendid bill that is now law. It was just a terrific bill.

And then we come to the Endangered Species Act. If I've ever seen bulldog qualities, you've got them. You've tenaciously pushed forward with that bill, which we reported out of this bill 15 to 3 over a year ago. It's been on the calendar. We've run into all kinds of obstacles, but you persevered—and I'm keeping my fingers crossed on both hands—but it does look as though we're going to be able to get that on some kind of a measure, and the clearance, as best as I understand it, has been worked out with the House of Representatives to take our bill. It's all due to your work.

So, Mr. Chairman, I just want to say two things—salute you for what you've done, and you're going to be missed.

Senator KEMPTHORNE. Well, thank you, Mr. Chairman.

Senator Chafee, let me just say what a great pleasure and honor it has been to serve with you. You have guided this committee with great leadership, and, again, we have some contentious issues here. Any time we're going to deal with environmental issues, they're going to be tough, but you have guided us with finesse and vision, and, again, Senator Chafee, it's a great pleasure to have worked with you but also to know that I have a friendship that I take with me.

Thank you very much.

And now I have invited Senator Craig, the senior citizen from Idaho, to join me for this hearing.

Senator Craig, welcome.

STATEMENT OF HON. LARRY CRAIG, U.S. SENATOR FROM THE STATE OF IDAHO

Senator CRAIG. Well, Chairman Kempthorne, let me thank you very much, but let me, first of all, associate myself with the remarks of the chairman of the Full Committee of Environment and Public Works on behalf of you. It has been my great pleasure to work with you the last 6 years, and to watch your hard efforts and successes in the areas that Senator Chafee has mentioned.

This issue that you have before us this morning is one that you and I and the Pacific Northwest will wrestle with for some time to

come, and whatever the outcome, the solution might solve the problem but it might wipe out the patient, and I think we've got to be careful that we bring that kind of balance.

Better understanding the important issues allow this hearing to be what we need today. As policy makers in the Pacific Northwest, we are going to have some weighty decisions to make. Your hearing today—I will probably, along with Senator Gorton, host a hearing in November after we get some other decisions out. But in regard to the topic at hand today, let me state for the record that I, like many Idahoans, was startled last week by the spin contained in some newspaper accounts about the recent release of the scientific report allegedly concluding that dam breaching was the only way to save salmon in the Columbia–Snake Rivers. After reviewing the report and discussing it with scientists associated with the development of the report, it is apparent that advocates of dam breaching and some media organizations simply jumped the gun.

The chief architects of the report readily acknowledged, indeed highlight, that there are inherent infirmities with conclusions of the report.

Will Stelle, Regional Director of the National Marine and Fisheries Services, stated yesterday that the level of uncertainty in the models used by the scientific panel is very high. The conclusions contained in the report are in no way absolute. They are merely relative probabilities with wide gaps between what is known and what is not known. These observations underscore the need for further research on matters, such as the impact of marine mammals, predators, and of our outgoing smolts, the impact of ocean conditions on the salmon, the impact of the release into the ocean of large numbers of hatchery fish along the western coast and continued research of hatcheries and genetic resources.

Mr. Chairman, thank you for the hearing today and for addressing this with the subcommittee.

To now say that the science on salmon recovery is settled is to expose either a great ignorance of the complex science associated with salmon recovery or a political bias in favor of the experiment of breaching dams. In either case, considering the tender box nature of the salmon debate in the Pacific Northwest, such a statement is destructive and irresponsible of anyone who would make it.

According to those who have been charged with the difficult task of determining the best science on salmon recovery, there simply is no credible scientific evidence at this time that removal of dams is the sure way—let me put it that way—the sure way to save salmon. Until such time as the PATH scientists decide they have accumulated all of the credible evidence available on this issue, we cannot expect scientific conclusions contained in interim reports to be final on the issue of salmon recovery.

In the meantime, responsible parties should show restraint with their rhetoric. No responsible person in the Pacific Northwest wants another spotted owl controversy or the kind of outcome from that. The wounds from that controversy manifests in the form of deep mistrust, both toward government and the environmental community, and have yet to heal fully. We all would do well to re-

main mindful of that catastrophe as we work with the salmon issue.

Mr. Chairman, seeking information in a forum such as this where the public gets an opportunity to see for itself the current state of knowledge on specific salmon issues is extremely helpful, certainly goes a long way to help dispel the growing mistrust out in the Pacific Northwest. The States of Oregon, Washington, Idaho and Montana can be either positively impacted or very negatively impacted, depending on the conclusions drawn and the ultimate plan developed for the saving of these very important fish.

So thank you for the hearing. You and I and others, I am sure, are going to stay actively involved in this issue and turn up our interest greatly over the next year or two, as we come to a conclusion and, hopefully, the right settlement and the right management plan for this river system. Thank you.

Senator KEMPTHORNE. Senator Craig, thank you very much. I appreciate your comments.

In addition to Senator Craig and other members who serve on this Committee, I invited the other Senators from the States that are dealing with this issue. So they may join us at some point this morning, but, again, it is something that from a regional basis we need to all work together.

In today's first panel we have asked three scientists and engineers to share with us some of their work on these essential issues. Our first witness, Dr. Roby, began an overview study of avian predation on the Columbia–Snake River system several years ago. In the course of that study he discovered that one particular species, the Caspian tern, was having an inordinate effect on the out migrate salmon smolts, due to its preferred method of fishing and the location of its nesting colony. We are hoping to explore with today's witnesses the possibility of non-lethal means to control this excessive predation.

Our second witness is Dr. Cloud, a fish geneticist, who has been studying the genetic effects of hatchery fish on the wild runs of salmon and steelhead. In addition, Dr. Cloud has made a proposal for a gene bank for Native Northwest fish that will give some insurance that we can preserve some of the declining diversity for future use.

The third witness is Richard Fisher, who works for the Voith Hydro Generation Company. We are glad to see you again. In his work at Voith, Mr. Fisher oversees the development of new technologies, including the advanced hydropower program authorized through the Water Resource Development Act.

In the second panel we will hear how our agencies have been responding to these issues. I hope that as a result of this hearing we can look forward to new ways to incorporate the information coming from our scientists and engineers.

So, with that, let me call the first panel forward.

Dr. Roby, welcome. We look forward to your comments, and we'll make—those of you who have your formal presentation, we'll make them part of the record, but if you could give the highlights in approximately a five-minute opening statement, then we'll open it to questions.

So, Dr. Roby?

STATEMENT OF DANIEL D. ROBY, OREGON COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT, OREGON STATE UNIVERSITY, CORVALLLIS, OREGON

Dr. ROBY. Thank you, Mr. Chairman, and members of the committee.

Good morning, my name is Dan Roby, and I am testifying regarding the issue of bird predation on juvenile salmonids in the Columbia–Snake River estuary. I am an associate professor in the Department of Fisheries and Wildlife at Oregon State University, and the Assistant Unit Leader for the Oregon Cooperative Fish and Wildlife Research Unit, which is part of the biological resources division of the U.S. Geological Survey.

For the last 2 years I have been the principal investigator for a research project entitled, "Avian Predation on Juvenile Salmonids In the Lower Columbia River." This project was jointly funded by the U.S. Army Corps of Engineers and the Bonneville Power Administration, and has been carried out cooperatively between the Columbia River Intertribal Fish Commission and Oregon State University. My colleague, Ken Collis, a biologist with inner-tribe, deserves much of the credit for this study.

I am testifying today in my capacity as a research biologist with no management authority or responsibility on this issue. To briefly summarize our research results from 1997, we found that the largest Caspian tern colony in North American resides on a dredge material disposal island in the Columbia River estuary called Rice Island. This island was the nesting site for over 16,000 terns and also supported the second largest double-crested cormorant reading colony on the Pacific Coast of the U.S. and Canada, consisting of over 2,400 individuals.

Another nearby artificial island, East Sand Island, supported the largest double-crested cormorant colony on the Pacific Coast, consisting of over 10,000 individuals.

Finally, both of these island, plus a third, also provided nest sites for over 20,000 Western gulls.

All three of the colonially nesting water birds are known to include juvenile salmonids in their diets, and the nesting period for these colonies generally coincide with a period of juvenile salmonid out-migration.

Our data indicated the Caspian terns were most reliant on salmonids as a food source, amounting to about 75 percent of food items taken. Double-crested cormorants were less reliant on juvenile salmonids at 24 percent of food items, and only about 11 percent of the diet of Western gulls consisted of young salmon.

We used a bioenergetics model to estimate the numbers of juvenile salmonids consumed by the Rice Island Caspian tern colony in 1997. We estimated that between 6 and 25 million juvenile salmonids were consumed by Caspian terns, or approximately 6 to 25 percent of the estimated 100,000,000 out-migrating smolts that reached the estuary in 1997.

In addition, estimates of the number of juvenile salmonids lost to cormorants and gulls in the estuary were in the millions.

So far our preliminary analysis of 1998 results indicates that the Rice Island Caspian tern colony has increased by more than 20 percent over 1997. The prevalence of juvenile salmonids in the diet

has remained about the same, and our estimates of the numbers of salmonids consumed by the tern population are similar to 1997.

The magnitude of Caspian tern predation on juvenile salmonids has been a cause for considerable surprise and concern, and drew an immediate and strong reaction from fisheries managers. There is substantial pressure to initiate management immediately in order to mitigate the impact of Caspian tern predation on smolt survival. One of our research objectives for the 1998 field season was to test the feasibility of potential methods to reduce predation on smolts by Caspian terns. Based on that work, one potential management option is to translocate the tern colony to a site closer to the mouth of the river, specifically East Sand Island, and if I could, have the map put up there so that everyone could appreciate the locations of Rice and East Sand Islands in the estuary.

Let's see, Rice Island is sort of right in the center there, and East Sand Island is all the way to the left, very close to the mouth of the Columbia River. So Rice Island is the current site for the Caspian tern colony, and what we would like to do is potentially translocate that colony to East Sand Island, which is close to the mouth.

Moving the tern colony from Rice Island to East Sand Island may be an effective method to mitigate losses of smolts to terns because a greater diversity of forage fishes are available near East Sand Island. For example, double-crested cormorants nesting on East Sand Island consumed a much smaller proportion of juvenile salmonids, only about 10 percent of food items, compared with cormorants nesting on Rice Island, which consumed about 55 percent salmonids.

In 1998, our small pilot study demonstrated that Caspian terns could be attracted to nest at an alternative site on another island using tern decoys and an audio playback system broadcasting the sounds of a tern colony. These research results suggest that translocating the Caspian tern colony from Rice Island to East Sand Island near the mouth of the river is a feasible short-term management option for reducing tern predation on juvenile salmonids.

Longer term management may include attracting portions of the current Rice Island Caspian tern population to nest outside the Columbia River estuary. Potential locations include former Caspian tern colony sites in Willapa Bay, Grays Harbor and Puget Sound in the State of Washington, colonies which no longer exist because of human activities. There is evidence that these former colonies have coalesced to form the very large Rice Island colony. Re-establishing these colonies may provide considerable benefits for salmon restoration in the Columbia River Basin and reduce the vulnerability of the tern population to localized catastrophic events.

Management action focusing on tern predation in the estuary may be an effective and efficient component of a comprehensive plan to restore salmon to the Columbia River Basin. There is consensus support within an interagency working group to pursue translocation of the tern colony in 1999.

However, adequate funding has not been committed for this management activity, nor for continued monitoring and evaluation of this problem.

Thank you very much.

Senator KEMPTHORNE. Dr. Roby, thank you. It's fascinating, and you are to be commended for your discovery. I visited Rice Island in August, and it's an incredible situation, so I look forward to the discussion here.

The idea that this is a man-made island from the spoils of dredging—and I really didn't know what to expect, but I believe it's 238 acres. I mean, it's a vast island, and we'll get into the details of the consumption of the smolt.

Dr. Cloud, we look forward to your comments.

STATEMENT OF JOSEPH CLOUD, PROFESSOR OF ZOOLOGY, DEPARTMENT OF BIOLOGICAL SCIENCES, UNIVERSITY OF IDAHO, MOSCOW, IDAHO

Dr. CLOUD. Good morning, Mr. Chairman, and members of the committee.

My name is Joe Cloud. I am a faculty member at the University of Idaho. I am also a member of the Washington State University of Idaho Reproductive Center.

My research expertise is actually in fish reproduction and early development, and my expertise in that area is in salmonids. My objective this morning is to sell you on the idea of genetic insurance for our fish runs.

Many fish populations around the world are declining, whether there are dams or not. Some of the causative factors that have contributed to these declines are over fishing, habitat destruction or degradation, population and genetic introgression.

Regardless of the causes, a decrease in the size of a population can result in a decrease in the diversity of genes within a population. Because many of the unique characteristics of various fish stocks are genetic adaptations to local conditions, the loss of these genes may result in a decrease in the probability of long-term survival in the native habitat of these populations. Since a number of the causes for declines in fish populations are due to activities of the human population, many of the problems that contribute to these declines can be corrected, but these corrective actions may require extended periods of time, and we may be running out of time.

In order to reduce or reverse the declines in fish populations, fish hatcheries have been established to mitigate the loss of native spawning habitat and to enhance the reproductive output of fish stocks. Although fish hatcheries have generally been very successful in the production and rearing of fry, the resultant gene pools of the hatchery populations are not always the same as the native stock from which they were derived. Thus, although hatcheries have been an important tool for the enhancement of fish populations, they have some inherent weaknesses relative to the maintenance of the original genetic composition of the fish stocks.

Therefore, what I propose is that in order to re-establish populations, if we should lose them, or to help fish hatcheries maintain genetic diversity of the native population, gene banks should be developed.

At present, the cryopreservation of sperm is the only functional means of storing fish germ plasm for genes for extended periods of time. This technological is actually transferred from the freezing of

bull sperm in the dairy industry into fisheries, so this is not new technology. It has also been transferred for many of the marine and fresh water fishes around the world, so it is a technology that has been used by a lot of different people under a lot of different circumstances.

At this point in time, it is fair to conclude that probably all species of fish—the sperm of all species—can be cryopreserved.

Additionally, since the storage time for fish sperm held in liquid nitrogen has been estimated to be greater than 200 years—a minimum—the time scale for the storage period is more than adequate for a germ plasmas repository. Now, the establishment of gene banks for fish populations is not a hypothetical suggestion. It is a program that has a successful track record. This technology has been utilized successfully by a number of different countries in the establishment of fish germ plasma repositories. Norway, for example, has initiated the extensive effort to collect and preserve germ plasma from native Atlantic salmon.

In 1986 the Directorate for Nature Management in Norway established a national gene bank program. At present their repository contains milt from over 6,000 males, and this represents 155 different salmon stocks. They also have other stocks in trout that I didn't add.

Although there is no national program in the United States, there are regional programs involved in the collection and cryopreservation of fish sperm. In the Northwest, our laboratory, partnered with a group at Washington State University and the Nez Perce Tribe, has initiated the development of a gene bank for chinook salmon that spawn in tributaries of the lower Snake River. At present, our efforts have resulted in the cryopreservation of the sperm from over 500 males from 12 tributaries. Our efforts were initiated in 1992 and continue to the present. Although our efforts have been limited by funding, we are determined to save at least a portion of the gene pool of these stocks.

Now, having said that, the major advantage of a gene bank program at this point in time is that if that stock becomes extinct, the only way to re-establish that stock is to use the cryopreservation sperm, and to use a relative of that stock so that you can then use a back-crossing scheme to get back to nearly the original stock. A better way of doing this would be to preserve fish eggs. That, at the moment, is not available. It is a very tough biological problem, and with a lot of time and a lot of funding, it will still be a tough go.

In conclusion, it is my belief that the human population has an intrinsic need and responsibility to preserve the genetic legacy of our fish populations. Fish cryopreservation or genetic cryopreservation of existing fish stocks is an important goal in itself, and, as a component of programs designed to ensure a viable and sustainable fishery under changing environmental conditions. With the constant threat of losing genetic diversity in specific native stocks, as a result of declining population numbers or the result of genetic selection pressures and hatcheries, the establishment of a program for the long-term storage of fish germ plasma would serve as a back-up and insurance for the presently ongoing conservation programs.

Now, there is an important caveat to this proposition that I would like to leave you with. Just as an insurance policy on your automobile will not maintain that automobile, or increase the life span of that automobile, likewise, this germ plasma repository that I am suggesting is not going to solve our problems. It will not put fish in the river, it will not increase the number of fish in the population, but what we will get is the genetics, and at the end of the day when we cryopreserve that semen, we can look in the tank and we can know that the genetics is available 100 years from today.

Thank you.

Senator KEMPTHORNE. Dr. Cloud, thank you very much, and you are to be commended for your work.

Mr. Fisher, nice to see you again. We look forward to your testimony, and I know that you have some models here of advanced hydro turbine design, so if you need to be mobile so that you can show us those—we just would like to somehow have you stay near the microphone. You can take it with you.

Thank you.

STATEMENT OF RICHARD K. FISHER, JR., VICE PRESIDENT, TECHNOLOGY, VOITH HYDRO, INC., YORK, PENNSYLVANIA

Mr. FISHER. Thank you very much, Mr. Chairman, for inviting me to testify—good morning, Senators.

Let me introduce myself. My name is Dick Fisher. I have worked in the hydro industry for over 27 years. For the last 10 years I have led my company's research and development efforts. I am the current chairman for the International Association of Hydraulic Research, and I pride myself as a leader in moving the industry, the hydro industry, toward developing a more environmentally compatible hydropower system.

Hydropower was this nation's first electrical power generation source. It's domestic, it's renewable, it's reliable and it's clean. Compared to other significant sources of power generation, hydropower is one of the cleanest with respect to global warming emissions. Hydropower can contribute near-term to reducing greenhouse gases, if allowed to grow. However, as we all know, hydropower has a tarnished image, particularly in conjunction with the dams, which are necessary to make it work. However, it can be improved and hydro systems can be managed to maximize benefits for all stakeholders.

In 1993, an industry and government cooperative project under the stewardship of the Department of Energy was launched called the Advanced Hydro Turbine System Project. This project has three phases—phase 1(A) is now complete. This particular phase developed four design concepts for improved hydro systems to improve the environmental compatibility. Two of those phases relate to salmon passage on rivers like the Columbia River.

Voith, in its design concepts, addressed the 70,000 megawatts of existing hydropower, and looked at how that could be improved to boost its environmental compatibility, as well as providing a boost in energy production during the rehabilitation. In fact, we have reached some solutions to be able to do that, and we have been working with some of our customers to do that. As you can see on this chart, the green or lower curve represents an existing project

on the Columbia River at Wanapum Dam, and in working with the engineers at Wanapum Dam, we were able to develop a new design, which is the red upper curve, which has significantly more power generation—about 20 percent more power generation from the existing machine—and, at the same time, using the water mower efficiently, and, at the same time, having the potential of halving the mortality of fish passing through that project.

This project at the moment is only in the design phase. The design is complete, and it is ready to roll. Unfortunately, it is on hold because of regulatory restrictions.

These models over here represent the work done for Wanapum Dam, and I'll get to those in a minute.

As you know, small changes can lead to an overall survival increase on a river system like the Columbia River where the salmon must pass through a cascade of dams. A three or four percent change in one project can add itself up to a 25 to 50 percent change in the overall river system. The goal of the advanced hydro turbine project with respect to large Kaplan turbines, which lay on the Columbia River, is to take today's 80 to 94 percent fish passage survival and boost it to the area of 98 plus percent, and we think that is achievable. In fact, we think the model that is on the table over here for Wanapum Dam could today reach 97 percent at its best operating condition, but it is not yet proven.

If we can get the large Kaplan turbine fish passage survival up to 98 percent, then there would be no need to have fish bypasses, no need to have excessive spill to pass water over the dams because the estimated fish passage survival of spill and of bypasses would be then equal to, or less than, what can happen if the fish are passed through the turbines themselves. So there would be no need to waste energy by spilling water or by bypassing water.

As I mentioned, these are two examples.

[Displays exhibits.]

The example on the left represents an existing hydro turbine at Wanapum Dam. The example on the right is the result after that particular turbine has been redesigned. Into that design are four of the six concepts that we came up with that would make a Kaplan turbine more environmentally friendly. Not all of them have been included in this rehabilitation plan, but four of them have.

You can see on the chart at the right here the red line represents a first generation Kaplan survival on the Columbia River—87–88 percent fish survival has been calculated for this machine. The green line on the top represents what could be achievable from the rehabilitation at Wanapum Dam, a significant boost in fish passage survival.

In conclusion, I would like to say from my experience that significant improvement can be made now, today, to boost both the environmental compatibility of hydro and to also provide a boost in energy generation. We think as much as 7,000 megawatts of additional hydro capacity can be generated in the United States through a rehabilitation of the existing projects that are out there while we boost their environmental compatibility at the same time.

Much still remains to be done. It can be done slowly in a step-by-step process, or it can be done in a much more rapid way by doing various things in parallel.

Today's AHTS plan has the next step doing what we call phase 1(b), refining and understanding more clearly the mortality mechanisms affecting the fish as they pass through hydro sites and dams on their way downstream. This is a long-term project to further refine our knowledge.

There are also two other phases in this project—both of those are related to testing and validating design concepts; phase 2 looks at small scale model testing; phase 3 looks at testing of prototype turbines. We think the Wanapum Dam turbine is ready for prototype testing today. While it may not reach our ultimate goal of 98 percent survival, it will certainly make a significant improvement over existing machines while we're working on phase 1(b) and gaining further knowledge for design sophistication.

Government and industry partnership will be required to move ahead with this goal. We would like to thank you, sir, for your past support, and we are where we are today because of it. To reach our goal, industry asked for your continuing support, both financial and also with your support in terms of removing the disincentives that are there through regulatory restrictions that are preventing projects like Wanapum from moving ahead with installing these fish turbines.

I would like to thank you, Mr. Chairman, for your leadership in this issue. You will be sorely missed when you become Idaho's next governor.

Thank you also, Senator, Craig, for your support. We look forward to perhaps your picking up the torch and carrying it forward.

Gentlemen, thank you very much.

Senator KEMPTHORNE. Mr. Fisher, thank you, and before you conclude your testimony—I appreciate your comments—but I would like you to go to these models and just in layman's terms show us what an existing turbine is and what the new design would do. I need you to take that microphone with you. If those models are mobile, if you could, perhaps take them back to the table—

Mr. FISHER. Yes, they are certainly mobile.

This particular model, Senator, represents the conventional style Kaplan design. Based on the economics of the era when these were developed, they were generated to provide the maximum energy possible, based on the technology at the time and some mechanical design simplifications were made that resulted in spaces between the blade of the Kaplan and the rotating hub, here, between the blade tip and the stationary shroud—or discharge ring—and the trout.

The water comes into the machine in this direction—this is just a segment of the machine. The water is swirled into the runner chamber. The blades rotate like boat propellers and catch the momentum of the water coming into the machine; they convert it into shaft rotational speed, which connects to a generator, which then produces the energy.

As the amount of power from these machines is changed—you step on the accelerator, so to speak—these blades change pitch. A flat position of the blade provides a little bit of output, a steep posi-

tion of the blade provides a large output, allowing more water through the machine. So as these blades move in response to the power needs, there are some geometries in here that have been detected as being unfriendly to fish. There are mechanical regions that can create a pinching, a chopping, a cutting of the fish. These regions also create flow environments that are very unfriendly to fish, creating fluid loads that can in effect tear the fish apart.

In redesigning these machines, we can remove these unfriendly areas. We can also improve the efficiency of the machine to allow it to extract more power, and also to more effectively remove the energy from the water. This example shows what has been done in the design for rehabilitation. Again, this machine has been converted from a conventional design to an AHTS design. We have changed what we call the wicket gates of the machine, which control the water in, to remove some unfriendly gaps on these machines.

We have changed the shape of the rotating hub to remove the unfriendly gaps at both the inner and outer section of the blades, so that as this blade moves—as these blades move in response to power changes, there are no gaps to create areas that can catch fish and there are no gaps that create leakages, which can create severe turbulence in the water that can injure fish.

So with some of these improvements, the minimum gaps, the improved efficiency, the improved blade shape to better guide fish around the blades, the removal of the gap on the wicked gates and so forth, this design can be taken from its current situation and upgraded about 25 percent in power. The mortality associated with this new design is estimated to be half of the old design and is a large step toward our AHTS objective.

Senator KEMPTHORNE. All right, Mr. Fisher, thank you very much.

And, may I note to Senator Smith of Oregon who has joined us, Senator, we are delighted that you are here with us this morning.

STATEMENT OF HON. GORDON H. SMITH,
U.S. SENATOR FROM THE STATE OF OREGON

Senator SMITH of Oregon. Thank you, Mr. Chairman.

I am here because of the hearing—it's of interest to me—and also to pay tribute to you. I know this is one of your last hearings, if not the last, and while I won't be able to work with you everyday, I will, as your neighbor, still be working with you on these issues.

So I thank you. I am curious, Mr. Chairman—first, may I have a statement put in the record?

Senator KEMPTHORNE. Yes, without objection.

Senator SMITH of Oregon. And, secondly, Mr. Fisher, why weren't you here yesterday?

Senator KEMPTHORNE. Go ahead, Mr. Fisher.

Mr. FISHER. The Wanapum Dam, the current site is operating—

Senator CRAIG. Mr. Fisher, would you pronounce the name of that dam again and locate it for us?

Mr. FISHER. The Wanapum Dam.

Senator CRAIG. Where is that located in the system?

Mr. FISHER. The Wanapum Dam is on the Columbia River. It is upstream from the Snake River. It is on the Columbia River side.

It is upstream of the bifurcation in the river where the Snake River comes in.

Senator CRAIG. Okay.

Mr. FISHER. It is a Grant County Public Utility District project. The rehabilitation project began in 1989 as a conventional rehabilitation of the existing machines, which have been in operation for over 30 years, and they are reaching the end of their life cycle.

So the Grant County Public Utility District is interested in—they have to rehabilitate these machines or they will fall apart. In 1995 this project was converted from a conventional rehabilitation to a fish friendly rehabilitation—in other words, taking advantage of some of the insight gained at the beginnings of the advanced hydro turbine project, and some of the insight that was gained in the past in developing some of these improvements.

This basic fish-friendly design was completed in 1996, and it represents about 95 percent of the advanced hydro turbine design concept. Significant changes to the design of the machine took place, including not only the rotating parts and the mechanical parts that I have explained here, but alsosome of the concrete parts that are existing in the dam, to make the further refinements.

The problems with that particular project are related to some FERC regulations, but, first of all, let me say that in 1996 this project was ready to go ahead and then it was decided to be put on hold, primarily because of the disincentives that were there. It was switched to a repair in kind project where, basically, duplicates of the existing machines which were there, were being installed.

In 1990, a FERC administrative law judge passed a requirement saying you must at Wanapum Dam pass 80 percent of the fish over this spillway—it's not 80 percent of the water but 80 percent of the fish—when the fish are there. So this project has a significant constraint to spill water. Therefore, they can't use that water to generate power. Therefore, when the Public Utility District Commissioners must evaluate the economics and the value to their rate payer in terms of how they move ahead in the future, they have to pay attention to this regulation. They also have to further recognize that another FERC relicensing would be required if they changed the design of the turbines. Furthermore the next 50 year normal FERC renewal of that license is due in about 2005, and it would have to go through, again, similar steps, and they were quite concerned that they will have considerable problems there. They are quite concerned that they will be required to further spill, and so they have made an economic decision at the moment that we cannot in good faith invest the $70 million that they had planned to invest in installing these fish friendly turbines. Instead, they are investing money to do a repair in kind, and we're losing a significant opportunity here, and, basically, these machines now are on the shelf.

Senator CRAIG. Senator Smith, I have looked at this in the relicensing process—just introduced legislation to deal with not this specifically but any time you retrofit and it is significant enough that FERC steps in with its current law and suggests that it is a need for relicense, you open up the entire process, which allows all of the other agencies to come in and create mandates into a new license. What Mr. Fisher just said, the 80 percent of fish over spill-

way, becomes one of those new mandates. It changes the whole economics of the project, and that is an issue that all of us in hydro based areas are going to have to be concerned about in the near future. The licensing process throws it wide open, and many of these projects are denied the ability to become what they could become simply because they run the costs up in so many other areas—there's Fish and Wildlife, National Marine Fisheries, BLM, Interior. All of these agencies can come to play, and say to a generating facility, "You must"—not that you should, but that "You must." No economic consideration, not even this, becomes a factor, so that's our big stumbling block at the moment, and it's something that you and I, and all hydro based areas are going to have to wrestle with because, while it may be good in some instances, it denies the good in others.

Senator KEMPTHORNE. What I would like to do now is begin a round of questioning. Each member will have five minutes, and we'll just keep moving through this, so I will begin.

Dr. Roby, again, I commend you for your study and your discovery. I would ask when you have come to the conclusion that anywhere from 6 to 25 million smolt are being consumed by the Caspian tern, how did you come to that figure?

Dr. ROBY. Well, we used a bioenergetics model, which is probably the only really accurate way that we can get at these numbers. It's been used in a number of other situations where the question has been asked how many fish, or frequently game fish, are being consumed by fish-eating birds? So the bioenergetics modeling approach is state-of-the-art at this stage, but it is only as good, of course, as the input variables that you provide for the bioenergetics model, so over the last 2 years we have been doing the best we can to try and generate the best input variables.

Senator KEMPTHORNE. And, Senator Smith, before you arrived Dr. Roby had described Rice Island, and you may be familiar with it, but it's a very large island and the Caspian tern has moved in there.

Now, Dr. Roby, would you explain—it's my understanding that the smolt is there migrating toward the ocean. They are still at the surface and there is some wedge where you have the salt water and the salinity coming in, but there's still at the surface at this particular location. The idea of moving these Caspian terns to another island at that point the smolt will not be on the surface.

Can you give me some idea?

Dr. ROBY. Yes, that's a hypothesis actually that Dr. Karl Schrek, the Unit Leader at the Oregon Cooperative Fish and Wildlife Research Unit came up with, and he is in the process of testing that hypothesis. We don't have a lot of firm data that show that smolts when they reach the estuaries, are not ready to go through smoltification, the process of getting ready to go into sea water, that they will linger in the estuary, near the surface, which is where the fresh water stays, and, therefore, become more vulnerable to Caspian tern predation.

But that is certainly a good working hypothesis, and we hope to test that hypothesis over the next few years.

Senator KEMPTHORNE. Also, the relocation of these birds. How would that be accomplished?

Dr. ROBY. Well, the proposal is to use a combination of trying to attract them to the new site through creating attractive Caspian tern nesting habitat, which is basically bare sand. We're going to try to create the habitat conditions on East Sand Island. We'll attract the birds, put out several hundred Caspian tern decoys and several playback systems that will broadcast essentially Caspian tern's greatest hits, and, hopefully, attract lots of birds to that area.

Then, the real question is what do we do to make Rice Island, their current colony site, less attractive to Caspian terns? I think probably the best way is to try and vegetate, or, as someone said, naturalize Rice Island. Rice Island is, as you said, an enormous dredge material disposal island. It is almost all bare sand. It seems like when you're on the island, there is almost an unlimited supply of Caspian tern nesting habitat, but if it can be vegetated artificially initially and then allowed to go through succession to a natural vegetative state on the island, then it will be unattractive to terns.

Senator KEMPTHORNE. Okay. To understand these numbers—now, you're estimating that 100 million smolt are going down the river.

Dr. ROBY. That is not my estimate. The National Marine Fisheries Service estimates that approximately 100 million juvenile salmonid smolts reach the estuary or reached the estuary in 1997. I think their estimate in 1998 is slightly higher.

Senator KEMPTHORNE. And you're estimating that approximately 20 million or 25 million are being consumed by the Caspian tern.

Is that just by the tern or is it also by the cormorants?

Dr. ROBY. Our estimates for just the tern population are 6 to 25 million in 1997, and, even though we're still crunching the numbers from 1998, it looks like it will be a similar range for 1998.

The cormorant and gull numbers are in addition to that, and we didn't acquire sufficient unbiased representative data in 1997 to come up with an estimate of the number of smolts consumed by cormorants and gulls, but we are confident that it was in the millions, and this year's data will tell us how many millions—or at least give us a range.

Senator KEMPTHORNE. And is there any way then—Mr. Fisher your comments about if we could cut in half the mortality of the smolt going through the dams, how many smolt that is? In other words, how many smolt can we save by this new advanced hydro turbine?

Mr. FISHER. I am sorry, Senator, but I don't have any concept of the number of smolts that go through the machines. I have only been concentrating on the mechanisms.

Senator KEMPTHORNE. Okay, I think a key point that you make is that at each dam it is a multiplier?

Mr. FISHER. That is correct.

Senator KEMPTHORNE. I don't know, Dr. Roby, if you can help us—perhaps not here—but if you could provide for the record somehow that we can estimate, if you have a multiplier effect of the dams on the river, how many smolt will be surviving as opposed to be killed, and then if we are successful in relocating the Caspian

tern, it seems to me that's going to make a significant impact, a positive impact, on smolt getting out to the ocean.

Is that accurate?

Dr. ROBY. Yes, I think the biggest problem for those of us that are working on this issue, and it's a very difficult one, and there are a lot of factors involved in why we've been unsuccessful in restoring salmon to the Columbia River Basin, but just from my perspective as a biologist working on the avian predation issue, a big question that remains in my mind—and I know that Carl Shrek has asked the same question in other venues—is if we were to eliminate avian predation tomorrow, how many more adults would we get back. Because it's the adults we want and we desperately need, and we're not sure what the answer to that question is. Different people with different axes to grind will claim one way or the other that for every smolt that you get out in the ocean, you will get a percent of an adult back. The mortality due to tern predation and bird predation in general is not totally additive. There's some compensatory mechanisms, and, by that, I mean that birds may be taking fish that might not otherwise survive.

Senator KEMPTHORNE. I need to allow Senator Chafee to continue the questioning. I am not a scientist; I am a layman, but it seems to me—and I understand that you can't predict how many adults will come back, but if we can through our efforts have 25 percent more smolt get to the ocean, we have increased the probability that more adults will come back.

Is that accurate?

Dr. ROBY. Yes.

Senator KEMPTHORNE. Okay, thank you.

Senator Chafee?

Senator CHAFEE. Senator, I am in no rush if you want to continue.

Senator KEMPTHORNE. No, no, please, go ahead.

Senator CHAFEE. Dr. Roby, this is a very interesting proposal and discussion that you have.

First of all, not that we're getting casual up here with money, although we do deal in big sums, but I must say that the amounts that you were referring to that you would need, $204,000, seems relatively small to us. And, again, I'm not glossing over the amount of $204,000, but I'm just surprised that you're not able to come up with that money. I hope that perhaps we can do something to be helpful to you in your studies, and I don't know quite how, but I just wanted to comment on that. Usually, we're confronted with problems that are going to cost billions, but this is a relatively modest amount of money.

I don't quite understand what is occurring out there. Are you suggesting from you testimony—first of all, are these indigenous birds, these Caspian terns? Have they been around for a long time in that area?

Dr. ROBY. Well, there's not a simple answer to that, unfortunately, but I'll try to give you a very brief one if I can, and that is that there appears to not be a history of Caspian terns nesting along the Pacific Coast of North American until the early part of this century, and no one is quite sure why this species expanded into the Pacific coast of North America starting in the early part

of this century, but by 1954 there was a small colony in Grays Harbor in Coastal Washington, and from those early, modest beginnings, the population along the coast of Oregon, Washington and California has grown. In fact, it looks like Caspian terns have increased, and probably doubled their population's size in North America over the last 15 years. So there are factors improving conditions for this species.

Senator CHAFEE. And, as I understood the answer you gave to Senator Kempthorne, the difference between moving them from Rice Island, which is further up the river from the coast, down to—what is it, East—

Dr. ROBY. East Sand Island.

Senator CHAFEE. —East Sand Island, the reason they won't do destruction to the salmon smolts is that when the smolts get that far down, they are further under the surface?

Dr. ROBY. Well, we hope that that happens but we're not sure that it will. What we are sure of is that there are more alternative prey in the area of East Sand Island, such as marine forage fish species, including herring, shiner perch, peamouth, anchovies. All of these forage fish species become available to them if they nest down near the mouth of the river at East Sand Island. In fact, the cormorants that are nesting on on that island are consuming a large part now.

Senator CHAFEE. They aren't taking the smolts?

Dr. ROBY. They're taking some but not near as many as the cormorants that are nesting on Rice Island where the tern colony is.

Senator CHAFEE. Now, are there certain scientists that say what you're suggesting is nonsense? In other words, is there a counter-prevailing view or counter-view to what you're suggesting?

Dr. ROBY. Well, yes, one criticism of this proposed management action is that by moving the Caspian tern colony on Rice Island a scant 15 miles down river, you're not going to change where the birds forage. Caspian terns are capable of foraging up to 40 miles from their nest site, from their colony site.

But from the studies that we've done in the estuary, looking at the distribution of foraging terns in relation to Rice Island, it looks like the majority of the terns are foraging within five miles of the colony, and 90 percent of them are foraging within 13 miles of the colony. So that leads us to suspect that if we can move the colony to East Sand Island, it will change their foraging distribution and it will change their diet, and they'll eat fewer young salmonids.

Senator CHAFEE. Well, my time is up, Mr Chairman. I want to thank you. This is very interesting. These are things I've never thought of—of course, I'm from Rhode Island so I suppose I'm not taking all my time thinking about what takes place on the Snake River and Columbia River, but I find all three witnesses have been excellent.

Thank you.

Senator KEMPTHORNE. Mr. Chairman, thank you.

The other alternative that Dr. Roby has not gone into detail on, though, is the concept we've discussed, which is relocating the colony to Rhode Island.

[Laughter.]

Senator KEMPTHORNE. Okay, Senator Craig.

Senator CRAIG. Dr. Roby, I too am fascinated by the work you've done. Your last comment is in relation to—from the point of nesting out, that a tern will travel for purposes of food.

Does not that have something to do with the proximity of the food itself or the food source itself? I mean, you've talked about a 40-mile traffic pattern, in essence, or the capability of that. If the food is at 40 instead of five, won't they go to 40?

Dr. ROBY. They will if they have to. The work that has been done with seabirds like Caspian terns has shown that they're energetically conservative and they tend to run a trap line sort of approach to foraging. In other words, they'll go out and they'll keep moving further away from the colony until they find a place where they can acquire the food that they need. As long as the food is in the vicinity of East Sand Island—and we think it is based on surveys of forage fish that the National Marine Fisheries Service has done in the estuary—they ought to be able to remain near the colony and still meet their food needs.

Senator CRAIG. Can the tern light on water and rest on water?

Dr. ROBY. Yes, Caspian terns are the largest tern species in the world, and they are capable of swimming, unlike most other tern species.

Senator CRAIG. So they will dive and swim?

Dr. ROBY. They won't swim under water. They forage by plunge diving, so they fly maybe 50 to 100 feet off the water and then drop into the water to capture prey.

Senator CRAIG. Tell me a little bit more about smoltification and the time it takes before this smolt, if you will, moves into the salt water, and, therefore, into deeper depths.

Dr. ROBY. Well, under normal circumstances, it takes a number of weeks, of course, for a young juvenile salmonid to travel down the river during the out migration and reach the estuary and go through smoltification and egress out into the ocean.

One of the issues that we think may be relevant to the problem that smolts have had with bird predation in the estuary is in the case of hatchery releases where essentially a target size is met, the fish are forcibly evicted from the hatchery, if you will, dumped into the river and they're on their own. In those sorts of circumstances if they reach the estuary, they encounter salt water for the first time, they are unprepared to deal with that through their gill's salt excretion mechanisms, and they reside there for a long period of time.

Again, that is a working hypothesis, but the alternative is for them to go out to sea and die very quickly, and barging is the same sort of concern because, of course, it gets them down to the mouth of the river—

Senator CRAIG. But it hasn't educated them along the way, has it?

Dr. ROBY. Yes, in record breaking time they get down there in 48 hours in what would have otherwise taken 3 or 4 weeks, and there they're confronted with, "Well, do I go out now or do I linger and take my chances with the birds?"

Senator CRAIG. How long have we known about the colony and what—you mentioned some growth factors. Is the presence of the

tern on this island relatively new and has it populated its nesting area at a very rapid rate?

Dr. ROBY. The first notice that this tern colony got was in 1987. Apparently, it was established in that year on Rice Island, which has been in existence since the early 1960s. But Caspian terns were first recorded nesting in the Columbia River estuary just 3 years before that in 1984—

Senator CRAIG. So they're a relatively new bird, at least to this estuary?

Dr. ROBY. That is correct, and they actually nested on East Sand Island, and then because that part of the island was vegetated, they moved to Rice where they found unvegetated sand.

Senator CRAIG. In your studies of predation we know there are other predators. The figure that you are giving us the National Marine Fisheries has developed at 100 million smolts.

That is 100 million smolts to the mouth of the Columbia?

Dr. ROBY. To the estuary, that is correct.

Senator CRAIG. To the estuary, and to the Rice Island area?

Dr. ROBY. That's right.

Senator CRAIG. Do you have any other figures as it relates to total predation or estimates of total predation in the Columbia system?

Dr. ROBY. For birds?

Senator CRAIG. Well, all. We know there are squaw fish, walleye, and bass and gulls—mammals, of course.

Dr. ROBY. Yes, marine mammals. That number, as far as I know, does not exist. No one has attempted the Herculean task of putting that together.

Senator CRAIG. But you are 100 percent certain that a smolt consumed by a Caspian tern in or near Rice Island will not be allowed to return as an adult salmon. Is that not correct?

Dr. ROBY. I think we can be safe in saying that.

[Laughter.]

Senator CRAIG. All right, I thank you.

Senator KEMPTHORNE. Okay, Senator Smith.

Senator SMITH of Oregon. Dr. Roby, was there a correlation in time when they began barging to the explosion in population of the Caspian tern?

Dr. ROBY. I don't believe there is a relationship there, and the reason I say that is because the terns themselves are not keying into barge releases, if you will. There seems to be no—I assume that's why you asked the question, or maybe I misinterpreted it. A recent newspaper article mentioned that essentially all the smolts that Caspian terns consume are greater than the number of fish that have been barged around the dam, and that, strictly speaking, is not supported by our data, but it is possible that that many fish could be consumed by the Caspian tern population, equivalent to what's barged.

But the terns because they're nesting in the estuary are not keying in on the barge releases, which are about 100 miles up river, I believe, and by the time they get to the estuary it looks like even though there may be a slug of smolts moving through at one time and the birds may be somewhat able to key in on that, it looks like

they have dispersed enough so that they're not forming a dense ball of prey for the Caspian terns.

We're in the process of collecting pit-tags, passive integrative transponder tags, from Rice Island where the tern colony is, and we want to try and answer the question, are barged fish more likely to end up being prey of Caspian terns than run of the river fish? We don't know the answer to that yet.

Senator SMITH of Oregon. Do you believe that Caspian terns are just background mortality or are they a serious problem?

Dr. ROBY. I believe bird predation is background mortality for smolts. I think there were always large populations of fish-eating birds in the Columbia River estuary, apparently not including Caspian terns. They seem to be a relatively new addition, but, certainly, cormorants have been there ever since Lewis and Clark came down the river. They even referred to them in their journals.

So bird predation isn't a new challenge or new hurdle for smolts to negotiate, but this particular Caspian tern colony may be something that they've never really—

Senator SMITH of Oregon. Something beyond background mortality?

Dr. ROBY. Yes.

Senator SMITH of Oregon. Dr. Fisher, I am wondering are these retrofits? Are there other dams where these could be applied where they are not being applied for regulatory reasons?

Mr. FISHER. Senator, yes, they can. In fact, all of the Kaplan turbine projects on the Columbia could have similar types of retrofits. Each of those machines is uniquely designed. Each of those machines would have a unique retrofit associated with it, but all of them could incorporate the fish-friendly features that have been identified as part of the design concepts. In fact, some of those are being incorporated now into the rehabilitation underway at the Bonneville dam.

Senator SMITH of Oregon. You say all of them could use it?

Mr. FISHER. All of the projects could benefit from this.

Senator SMITH of Oregon. But it is happening at Bonneville?

Mr. FISHER. Some of the modifications are now happening at Bonneville.

Senator SMITH of Oregon. How did Bonneville escape the FERC process without being inundated with new demands?

Mr. FISHER. I am not aware of that process. It's a Corps project that may be exempted from some of those regulations.

Senator SMITH of Oregon. So it's exempted from those?

Mr. FISHER. I am not sure—that's beyond my scope of expertise.

Senator SMITH of Oregon. I'm not sure either.

How much additional energy would that produce? Would that pay for the cost of retrofitting, and if so, in what period of time?

Mr. FISHER. The design developed from the Wanapum dam could produce about 20 percent more capacity because of the inherent characteristics of the design.

For Bonneville the machines were not designed to increase capacity, but they were designed to use the water more efficiently. So at Bonneville there is no more energy generated other than through better use of the existing use of the water that's there, but

at Wanapum about 20 percent improvement in its total plant capacity could be generated. So it depends on the design objective.

Senator SMITH of Oregon. The retrofit is $70 million?

Mr. FISHER. The retrofit from a conventional perspective, just retrofitting with a conventional design with a conventional scope of supply was estimated to be about $30 million. The incremental, another $40 million, was resulting from the increased scope to be able to get the environmental benefits. In other words, the conventional design got some of the increased capacity, but it didn't have all of the environmental benefits. An additional $40 million is associated with the—environmental issues.

Senator SMITH of Oregon. And how much improvement in fish mortality would this provide?

Mr. FISHER. We expect it will cut the existing mortality in half.

Senator SMITH of Oregon. In half. If it cost this amount of money, $70 million, and you produce 20 percent more energy, you've calculated how many years amortized paying for that?

Mr. FISHER. It amortizes within, I think, 10 years—something like that. It's relatively a sound investment. It's a win-win for industry.

Senator SMITH of Oregon. Thank you, Mr. Chairman.

Senator KEMPTHORNE. Senator Smith, thank you very much.

Mr. Fisher, some people have referred to the concept of a fish-friendly turbine as being an oxymoron. They consider that a turbine is in essence a blender as opposed to revolving doors that can safely allow the entrance and exit of a fish.

Would you address that concept?

Mr. FISHER. It's a size related issue, and it's a turbine design related issue. There are many different styles of turbine designs, some associated with small streams and a very high difference in what we call the head at the site or the potential energy at the site or the difference between the upstream of the dam and downstream of the dam.

On the Columbia River the heads are in the order of magnitude of 100 feet. The turbines are designed to be very large, and most of those machines are designed as Kaplan turbines. So, in essence, a Kaplan turbine can be envisioned as a revolving door, and a very big door, if you're a small fish.

The same style of turbine in a much smaller size that might be typical of a turbine in the Midwest or on the East Coast, same kind of Kaplan turbine. If it were one meter in diameter as opposed to 10 meters, which might be typical of the—or eight or 10 meters of the Kaplan—then the revolving door is much smaller. It is rotating much more quickly, and it gets real small and rotating real fast, and if the fish is big, then it becomes a blender.

So it is the relative size of fish compared to the turbine that is really significant. So for the Columbia big turbine and small smolts—it's a very favorable situation. The average fish passage survival—the direct survival of fish passing through the Columbia River turbines, the average is somewhere in the order of 90–92 percent. So those, by any stretch of the imagination, are not blenders.

Cutting those mortalities in half, or, even better, reaching the 98 percent goal would make a significant impact in being able to migrate the salmon smolts downstream.

Senator KEMPTHORNE. If we accept the National Marine Fisheries' figure of 100 million smolt in the river, and you go from a 92 percent to a 98 percent rate, how many additional smolt is that that are saved?

Mr. FISHER. That would—if it is 100,000,000 smolts reaching the estuary, then there would be probably three times—probably three or four times more smolts. I will calculate the numbers and let you know what those are.

Roughly, we have some statistics on this one chart. May I refer to this chart?

Senator KEMPTHORNE. Sure.

Mr. FISHER. We can see in this hypothetical example if all the turbines were 87 percent fish passage survival, and there were 10 projects on the river system—there are really eight, but 10 makes a nice number—then only 25 percent of the total fish starting at the first dam arrive at the last dam. If we can boost this passage survival up to 97 percent, which is this number, then there is a 50 percent improvement taking us from 25 percent of the fish surviving up to about 75 percent of the fish surviving.

So if that were 100 million fish starting the trip, 25 million would survive here; 75 million would survive here, roughly three times the number of fish.

Now, the fish don't all start at the top, they don't all go through all of the dams, or through all the turbines, and so the answer is not so easy, but a significant impact can be made.

Senator KEMPTHORNE. You see, again, it just strikes me that why in the world we don't get on with this type of new technology and science, why we don't get on with removing Federal restrictions and roadblocks because what you're discussing is the aspect of allowing more smolt to survive, and then we have a man-made Federal island that is consuming 6 to 25 million smolt because of a bird that's moved in. And it seems to me if we can address that aggressively, and Rice Island at 230 acres is a moving target because you're continually dredging the Columbia, and I don't know how many acres it will be in 5 years. And, again, it's the placement of that sand, which is the absolute habitat the Caspian tern wants, so it's going to have to be an ongoing management effort.

But it seems to me you can start adding together just these two steps, which somehow is going to aggressively allow many more smolt to make it to the ocean. Now, then we have to deal with this whole aspect of the ocean, but, boy, it seems to me there are some steps sitting right there in front of us that ought to be taken in an aggressive fashion, and, again, I don't know why we would not want to pursue that before we entertain the idea of breaching the dams.

Senator Craig?

Senator CRAIG. Mr. Fisher, not only do you create greater efficiencies of fish passage—and I understand the blender versus size concept. I was amazed when I was driven in a small pick-up truck into the turbines at Grand Cooley. There were some being repaired, and I had no fathom of the huge size of those, so if you can, in essence, take away the shape edges in some of the turbines, what you're saying makes sense.

But how does this concept—I think you had one chart that showed that only do you allow more fish to pass through unharmed, but you create greater efficiencies or a higher ability to produce energy. Is that not correct?

Mr. FISHER. That is correct.

Senator CRAIG. It becomes even a more productive turbine.

Mr. FISHER. That is correct.

Senator CRAIG. By what amount?

Mr. FISHER. It can range—as an example, at Bonneville dam, the improvement in the efficiency of the design was about six to eight percent, and that's operating efficiency. That means it uses the existing water more efficiently. If there is not enough water, then that would result in additional energy generation. In other words, the turbines are sized to take more water than is currently coming down the river.

At the Wanapum dam the turbines were designed to pass additional water, plus have an additional efficiency. So depending on whether there's excess water available or not, if there is excess water there, then they can use that excess water. If there is not excess water, then the efficiency improvements will use the water more efficiently and also generate more energy.

So it can range from three percent when there is a small amount of water there to as much as 20 percent when there is a large amount of water being spilled.

Senator CRAIG. So the great hypothetical is that if we retrofitted all of the dams in the Snake–Columbia system with these kinds of designs, or enhanced designs—not maybe these but these and others that would come along—we not only potentially up the amount of fish smolts we get out to the ocean, but we create an even greater energy source?

Mr. FISHER. That is correct.

That is a very attractive thing about the set of design concepts.

Senator CRAIG. I agree.

Dr. Cloud, one of the things that I participated in it at the State level and now here getting money to build hatcheries—and we've built a lot of them as fish numbers were declining or as we changed the characters of river systems, as you well know, as we changed the character of the lower Hells Canyon, built the Hells Canyon complex, built hatcheries, diverted fish, all in the name of saving, maintaining or increasing numbers, and then along comes our focus on these different species of salmon in the Snake and Columbia system and their listing, and all of the energy that we're into now, trying to resolve and save these fish.

One of the frustrations I've had—I think I understand it but it's still frustrating. We've had a lot of people say, ''Stop the hatcheries, stop the hatchery fish. Don't put them into the rivers. Let's go natural.'' I understand the vigor and the vitality of native fish and I've read as much as I could on it.

At the same time we do have a very large investment out there, and, properly run, it can produce a lot of fish into the system, but we've heard Dr. Roby talk about the intellect of these hatchery fish and all of that. I've read about that—don't criticize him, agree with it from what I've known.

You said something then that triggered my thought as it relates to the usefulness of hatcheries versus gene pooling. Did I understand you to say in the essence of gene pooling to save these last remaining fish that may be out there, and, as you know, that's true in some of these species that we're dealing with, that you would associate the ability to gene pool by freezing the sperm to be utilized in a hatchery environment to reproduce a new fish that would have those characteristics to be released into the system? Therefore, am I right, and are you suggesting, by your efforts or gene pooling, a value to the hatcheries that ought to be maintained as a part of the system?

Dr. CLOUD. What I was suggesting was that there are some inherent changes in the population or can be relative to the use of hatcheries, and this program of cryopreserving semen before that change occurs would allow you to have all of the genetics available when hatchery production can be approved—improved. I think that's all that this program will allow you to do is to have a back-up system.

I think—I am not a fisheries biologist so I'm talking really from a private opinion, but it looks like we need hatcheries to produce fish, and I think it's the best tool that we have at the moment, but I think that as time goes on we can improve that. So all a gene bank will allow you to do is come back and say, "Well, we have the genetics of that original population, so when we make those improvements, we can come back and be better off."

Senator CRAIG. I think all of us at least have concluded by studies that hatchery management needs to be improved and there are problems with it, as it relates to a lot of different aspects of the rearing of the fish, and the release of the fish, and what they do and don't do. But, of course, we've also got that debate out there, as you know, in our area that says hatchery fish in essence compete with native fish or pollute the process, or pollute the relationship of the environment in which a native fish prospers. And that has always been frustrating to me, so I was curious as to how you were seeing it in relation to the effective use of a gene pool because it does make sense to me that if we have the opportunity to ultimately change a system, a river system, to make it more fish-friendly—and that's our goal—then that's going to take time. You're not just going to go retrofit, and you're not going to change the island, and you're not going to do that overnight. It's going to take potentially decades of time and billions of dollars.

If we're hoping to save the fish and still save our production systems, and our slack water, and all of that that is valuable to the region, somehow it would be tragic to lose a couple of species of these fish in the meantime. You're suggesting that gene pooling may be that opportunity, at least to retain some of those characteristics to at some point in the future be able to reintroduce them into the system?

Dr. CLOUD. Exactly, Senator. So what this program would do would be to buy time.

Senator CRAIG. Thank you.

Senator KEMPTHORNE. Dr. Cloud, I would like to ask you a final question, and that is what would a gene bank program for the Columbia–Snake basin cost? If in fact we want to move forward with

this cryopreservation, with the idea that we could then preserve that material for up to 100 years, what's the price tag?

Dr. CLOUD. Senator, I think the price tag is variable. In a sense, you asked the question how much do you want and how fast?

I think that a ball park figure would be something like one and a half million a year annually—that would be more than adequate, and that would include a research program to try to bring on line the ability to freeze eggs as well.

Senator KEMPTHORNE. And do you think too, Dr. Cloud, that in the private sector there would be partners that would want to join in this effort?

Dr. CLOUD. I would hope so. If we look at the germ plasma repositories for plants, for example, that the USDA has, we have a large agriculture industry in our State. There may be some genes in those native populations that those folks may need, and I would like to see private industry be a part of that.

Senator KEMPTHORNE. Good, I appreciate that.

Well, to all three of you, you've been outstanding witnesses here this morning, and, again, I commend you for your work. I think it's exciting, and I think it gives us some of the suggested course of action that we ought to seriously not only consider but be pursuing. So I thank the three of you.

With that, I would like to call the next panel forward please.

In our second panel we will hear how agencies have been responding to these particular issues. I hope that as a result of this hearing we can look forward to new ways to incorporate the information coming from our scientists and our engineers.

I look forward to hearing from Colonel Eric Mogren of the Corps of Engineers. The Agency has been responding to the avian predator issue in the advanced hydropower technology opportunity. He is accompanied by Bob Willis of the Corps of Engineers.

And Danny Consenstein is with us representing the National Marine Fisheries Service. He will discuss the avian predator issue, the hatchery and harvest issues and we'll have comments on advanced hydropower.

Danny, it's good to see you again. We were partners in our visit to Rice Island.

With that, let me call upon Colonel Mogren, if you'd like to make your comments.

STATEMENT OF COLONEL ERIC MOGREN, DEPUTY COMMANDER, NORTHWEST DIVISION, UNITED STATES ARMY CORPS OF ENGINEERS, PORTLAND, OREGON

Colonel MOGREN. Thank you, Senator.

Good morning, Mr. Chairman, Senator Craig, distinguished guests. My name is Colonel Eric Mogren. I am the Deputy Commander of the Northwestern Division of the U.S. Corps of Engineers. I want to thank you for the opportunity to testify here today.

My testimony will address avian predation and turbine passage improvements, topics within the Corps scope from among those listed in the agenda that you sent out inviting me to be here.

Recent research has indicated that colonies of Caspian terns, gulls and cormorants in the estuary are consuming large numbers of salmon and steelhead smolts as these young fish make their way

to the ocean. Caspian terns nesting on Rice Island are the major part of the avian predation problem, as testified to by Dr. Roby.

They are also protected by the Migratory Bird Treaty Act. Our efforts must, therefore, focus on finding a balance so that we can provide suitable habitat within which both the terns and the salmonids can survive and prosper.

Rice Island was created in 1962 by the placement of dredge material. It is located about 20 miles upstream of the mouth of the Columbia River. Over the years it has become a nesting site for thousands of gulls, cormorants, and, since 1987, Caspian terns. Rapid increases to Caspian tern nesting colonies were noted in the early 1990s.

Due to concerns about avian predation on the young salmon as they moved through the estuary, the National Marine Fisheries Service's biological opinion on salmon in the hydropower system requested us to address this. We have come up with a short-term plan to address the problem that has presented some controversy. The birds have their supporters, as do the salmon. I believe the proposed plan balances these concerns, but we will see what responses we receive when we issue an environmental assessment for public review toward the end of this month. That environmental assessment is in draft right now and we expect to have it out by the end of the month.

I've been working with other Federal officials—namely, Will Stelle from NMFS and Ann Badgley from the Fish and Wildlife Service—to share responsibility for implementing this plan. While this is a multi-agency effort involving some of the best experts in the field, there is no guarantee that this near term plan will be fully successful. This uncertainty attests to the need for combined agency approach to a long-term adaptive management plan, including funding for those long-term efforts.

I would now like to address the topic of safer turbine passage for juvenile fish. While juvenile fish bypass systems increased spillway passage, and truck and barge transport for juvenile fish have greatly improved juvenile fish passage, a percentage of fish continue to pass the dams through the turbines. The survival rate for turbine passage is estimated at between 89 and 94 percent per dam. While this may seem to be a good survival rate, it diminishes considerably when multiplied by passage through as many as eight dams.

The Corps currently has a turbine passage improvement program underway. This turbine program is developed from a turbine passage survival workshop we held in 1995 to discuss with experts the possible mechanisms affecting survival of juveniles through the turbines. One of the ideas that developed is the concept of the minimum gap runners, which Mr. Fisher had talked to previously. It is believed that this design change will result in improved juvenile survival. We will have the first units available in 1999 for testing of this concept at Bonneville Dam.

In addition, in 1997 we initiated a turbine passage survival program. This is a 4-year program to identify potential areas of injuries to fish in turbine passage, and to design better turbines to reduce this injury. Power plans include model studies, and, if warranted, the field testing of prototypes.

Now, under the constrained fiscal year 1999 appropriation some of the turbine studies program activities may not be funded, and, as you know, sir, about $60 million came out in the conference report for the fish program against what the Administration had asked for, and I believe what the Senate came up with is $90 to $97 million. The regional systems configuration team met within the last couple of weeks and made a priority list of how they would like to see that $60 million spent.

Of the three turbine passage items that were on our listing, two made it above the line; one fell below. Senior managers at our division headquarters met just a few days ago, and they're going back in with a revised priority recommending the SCT reconsider that and have asked that all three of those turbine passage studies be put above the line. That's still a work-in-progress, though.

That concludes my statement. I thank you for the opportunity to testify, and I look forward to your questions.

Senator KEMPTHORNE. Colonel, thank you very much.

I might add, as you know, I've placed into the Senate's Water Resource Development Act $1 million for Caspian tern projects. So it's over in the House. Hopefully, something will be worked out today. There's be some problems, but we hope good turn deserves another.

[Laughter.]

Senator KEMPTHORNE. All right, all right.

Let me note here that the Regional Director of the U.S. Fish and Wildlife Service that was invited has not been able to attend this hearing. I understand that she has recently assumed the directorship and that there are many urgent matters that require her attention. I've been assured that the Service wants to play a constructive role in crafting the final decision of the interagency task force on the Caspian tern, and recognizes the critical importance of this issue. And, therefore, the Service has asked David Wesley to be here today to answer questions.

So, Mr. Wesley, thank you. We're glad that you're here.

There is a vote that is currently taking place on the floor of the Senate. So I'm going to recess the hearing briefly so that I can go over there and vote, and I'll be right back and we'll continue.

Thank you.

[Recess.]

Senator KEMPTHORNE. I'll call the meeting back to order.

Colonel, let's go ahead and just ask a few questions here.

You are ready to install the advanced hydro turbine, in other words, the fish-friendly turbine, and when will you will install them? Where will you begin?

Colonel MOGREN. Sir, Bonneville was scheduled for a major rehabilitation, and they are being installed at, I think, the Bonneville 1 Powerhouse, as part of that rehabilitation.

Mr. WILLIS. I think they're going in now, and I believe they'll be up and running by next year.

Senator KEMPTHORNE. All right, I think that's very exciting.

I understand that at one point Rice Island was provided to the Fish and Wildlife Serve as a bird refuge. Who owns the island now? Are there any other dredge-spoiled islands in the river that might become focal points for tern colonies?

Colonel MOGREN. Sir, as you know, the island was created through dredge spoils. By law it's owned by the State of Oregon, and part of it is owned by the State of Washington. It had been leased to the Fish and Wildlife Service as part of the Lewis and Clark game refuge back in the 1970s, I believe it was. That lease, as I understand it, inadvertently lapsed in 1994. So the ownership is the States own it, and, of course, we're operating it as a dredge disposal site.

With regard to your other question on other disposal sites, there's an island—Bob, could you point out Miller Sands Island?

Right next to Rice Island is Miller Sands, and, sir, you probably saw that when you were on the island. They're visible, within a mile of each other, and there's been some tern nesting there in the past, and then, of course, there's Sand Island up at the mouth of the river.

Senator KEMPTHORNE. I imagine, as I understand this, though, the other islands are heavily vegetated—I noted that from the helicopter. So as you add these dredge spoils, you are again creating that habitat that is conducive for the tern habitat?

Colonel MOGREN. Yes, sir.

Senator KEMPTHORNE. So now do you feel that this cooperative effort among the different agencies—is that working well? Are there any roadblocks to moving forward with the management program that we've discussed with regard to the avian predation?

Colonel MOGREN. Senator, I think in the short-term plan, we're in very good shape there. As I've mentioned, I've talked personally with Will Stelle on this of the National Marine Fisheries Service. I've talked with Ms. Ann Badgley, the Regional Director of the Fish and Wildlife Service. At the staff level, of course, we have excellent working relationships with the university researchers, such as Dr. Roby.

So I think at the working level and at the staff level, with regards to the short-term plan of trying this experiment and moving the birds from Rice Island out to East Sand Island, we're in pretty good shape with the agencies all cooperating fully to pull that off.

Senator KEMPTHORNE. Okay.

Colonel MOGREN. Incidentally, we just recently signed a three-agency letter, outlining to the Caspian Tern Working Group, asking them to develop a budget to start working on a long-term plan and put some meat on the bones, as we're proposing to do.

Senator KEMPTHORNE. Is there a lead agency among those agencies?

Colonel MOGREN. Sir, right now we're working in a cooperative manner among the three agencies.

Senator KEMPTHORNE. And is there anything additional that you need from Congress in order to be successful with that effort?

Colonel MOGREN. I think the—Senator Chafee mentioned the relatively small amount of money we're talking about here. I think it's $204,000 for the evaluation and monitoring plan. There's about $140,000 additional. The Corps is going to be putting up some of this—NMFS is putting up some of that this year—but if this turns out to be a long-term process and requiring long-term management of this very large bird population, which, as history has shown, is able to move pretty much where it wants to go, the funding of this

could be an issue here because none of the agencies have this right now in our current operating budgets.

Senator KEMPTHORNE. Okay, Colonel, thank you very much.

With that, let me call upon Danny Consenstein. Danny, if you would, give us your overview.

STATEMENT OF DANNY CONSENSTEIN, COLUMBIA BASIN COORDINATOR, NATIONAL MARINE FISHERIES SERVICE, SEATTLE, WASHINGTON

Mr. CONSENSTEIN. Thank you, Senator, Mr. Chairman.

I would like to thank you for the opportunity to testify here today. My name is Danny Consenstein, and I am the Columbia Basin Coordinator for the National Marine Fisheries Service.

What I would like to do is summarize my written testimony, submit the written testimony for the record, and then at the conclusion of my testimony I would like to take the opportunity to discuss a few points about the PATH report that Senator Craig had mentioned.

Senator KEMPTHORNE. That would be good.

Mr. CONSENSTEIN. So let me just hit the highlights of the testimony. The first point I would like to make is about the status of the endangered species in the basin. We need to remember that in the Snake River basin, and in the Snake/Columbia basin, we have three species of Snake River salmon that have been listed—the spring/summer chinook, the fall chinook and the sockeye. There are three species of steelhead that are listed—one in the upper Columbia River, one in the Snake River basin, and there's a lower Columbia steelhead that is also listed under the Endangered Species Act. We have proposed for listing three species of chinook salmon in the lower Columbia, in the Willamette and in the upper Columbia. The chum salmon in the Columbia River has also been proposed for listing and another two species of steelhead are also proposed for listing.

In addition to that, the Fish and Wildlife Service has proposed listing the bull trout in the Columbia Basin, coutney white sturgeon and some species of snails are also proposed or are on the list. So the picture of species that are at risk in the basin is wide and they impact just about all of the watersheds in the Columbia basin.

The salmon life cycle is complex in that salmon migrate long distances, and the human activities that have affected the salmon are also vast and cover everything through the ranges of habitat, and include degradation through a number of different sources—the effects of the hydropower system, and the effects of harvesting fish, the effects of fish hatcheries on the system. I want to stress that we need to take this kind of a comprehensive approach when we look at restoring salmon and steelhead and these other species in the basin to make sure that we look at all aspects of the salmon life cycle, and look at the ecological requirements of all of these diverse species.

Another point I would like to make is that we should use the best available science when designing this kind of a restoration program, and at NMFS, we believe that we can develop a basin-wide plan for the region that can restore these healthy salmon

runs, while at the same time maintaining a strong, healthy economy in the Pacific Northwest.

There are no quick fixes, and no silver bullets, but if we take this comprehensive approach, I think we can solve these problems.

So I would like to discuss, as we talk about in the region, the "Four H's", starting with "harvest," some of the actions we're taking in these various H's.

In harvest, we have restricted commercial, recreational and tribal treaty fisheries. Harvest rates in the past have ranged from 60 to 90 percent, and they have now been limited significantly from that. For example, for the Snake River spring/summer chinook, their harvest has been limited to between 5 and 10 percent for the past 15 to 20 years. We've been looking at that for a long time and right now that harvest is not considered a significant impediment to recovery.

Other significant reductions have been made for fall chinook and steelhead, for example, in this year's tribal in-river fishing on the Columbia River fall chinook stocks. The impact of that fall chinook fishery, on the steelhead, has been reduced from 32 percent to a range between 10 and 15 percent, so that's been cut in half this year.

On "hatcheries" we've proposed hatchery reforms that focus on natural populations, and that means using locally adapted broods—not using exotic broods, but trying to use the broods adapted for the local tributaries. In the future, we may have to use hatcheries more aggressively in specific areas where the risks of extinction are the highest, such as the captive broodstock programs that we've used in the Snake River.

What we're proposing is a broad assessment of the tributaries to determine where we're going to need to do that kind of aggressive hatchery intervention; and where, when, and how to develop a hatchery program that can address that.

I think we'll also have to look at the existing hatchery programs to see how they can be reformed. One example of the kind of research that we're doing at the NMFS Northwest Science Center is a program called "Natures" where we are looking at hatchery practices and trying to improve them in such a way as to improve the survival of those hatchery smolts. For example, currently most of them are raised in concrete raceways, and then they are sent out into a more natural stream, and they often don't survive very well. But we're trying methods where we put gravel and cover over the raceways so that they are raised in more of a natural environment. For example, they currently get fed from the surface so the fish learn when a big shadow comes over, it's bringing food, and then they go out in the wild, and when a bird comes over, they think that's food. So we're trying to make recommendations to improve hatchery practices, as well.

In the "habitat" arena, I think we all recognize that degradation of habitat has had an impact on the spawning on rearing habitats and that part of the salmon's life cycle. On Federal lands we've been using the Northwest Forest Plan, and the aquatic strategy developed in that plan to try to identify key watersheds and try to protect them. We try to provide some connectivity between high areas of quality habitat for salmon.

In the east side some of the data that's being developed through the Interior Columbia Basin Ecosystem Management Project, is going to be useful to also identify key watersheds on Federal lands there. On non-Federal lands it's a little bit more difficult how you identify habitats and how to protect them, but we've been using habitat conservation plans (HCPs), working with, for example, Washington State's Department of Natural Resources to protect State lands. We're also trying to work with the Natural Resource Conservation Service to give guidance to farmers so that they can protect salmon habitat on their private lands.

On the hydropower system, we're mostly guided by the 1995 biological opinion for the operation of the Federal Columbia River Power System, the FCRPS, and we're using an interim policy that we've come to call "spread the risk," where we are using a combination of measures to improve the in-river conditions that the smolts migrate through, and, at the same time, transport a significant number of smolts through the transportation system. We test that to see which one does better, and the data is coming back from those studies now.

These interim improvements have had the result of raising survival rates of juvenile spring/summer chinook through the system to a level now in the 1990s that is roughly double what it was in the 1970s. We're very supportive of the efforts to improve and to reduce mortalities through innovative turbine technology.

I don't know if you can see this chart from here, but this bar chart indicates the years down at the bottom starting in 1964, and all the way at this end it's 1998. On the left is the percentage of survival through the system from lower Granite dam to Bonneville, and this is for spring/summer chinook. It shows that in the early 1960s the total survival rate through the entire system was about 40 percent, and then it declined—we're not sure why—but it declined in the early 1970s down to one percent, two percent here, and there were some spikes where there were some good years. Then in this period of the 1980s there was a gap in the data, but now that we have really good data coming in, we can see that the survival rate for the system is back up to what it was in the 1960s when there were less dams.

So I think this shows that the efforts we have made through the 1995 biological opinion to improve the conditions has worked, and we are getting higher survivals through the system.

Now, I would emphasize, though, that the survival rate of smolts occurs down to the end of the system, but we're still not getting the adult returns that we need to ensure recovery. This is just another bar chart that shows what the kind of returns—

Senator KEMPTHORNE. I'll tell you what, Mr. Consenstein, if you would go to the other side because they're trying to pick it up here.

Mr. CONSENSTEIN. Should I go—

Senator KEMPTHORNE. Just hold it on the other side—that's good.

Mr. CONSENSTEIN. Is it okay? I know I'm beyond my time.

Senator KEMPTHORNE. You're doing well—about one more minute.

[Laughter.]

Mr. CONSENSTEIN. Okay, I'll wrap it up, but I just wanted to indicate that these are the actual returns for what they call the

smolt to adult return ratios, and it shows that when the stock was healthier back in the 1960s, the ratios were up around four percent, and I think that's what most scientists estimate. We need to have healthy runs, somewhere between 4 to 6 percent return ratio. That's what they were in the 1960s and 1970s and then they declined.

So here we are up in 1995—the latest year we have data for is 1995. We're still way down below one percent, so we've got a long way to go to get the returns back, and I think that's sort of the bottom line that we need to keep our eye on.

So let me move on and I'll try to quickly wrap up. On predation, we've had a lot of discussion today on that subject. I would just support most of what Colonel Mogren has said, and just say again that the three agencies involved in this—the Corps of Engineers, the National Marine Fisheries Service and the Fish and Wildlife Service—have been working closely together in the region to develop a plan, a short-term plan. Colonel Mogren mentioned the letter that all of the regional directors signed to the Caspian tern working group calling for some immediate action and an immediate plan, and we do intend to try to get this short-term plan implemented for the 1999 out-migration season.

We also have predation programs for fish mostly in the river, for what's known as the squawfish. Scientists like to call them the Northern pike minnow. We've had a management plan that is intended to test the hypothesis that predation can be reduced, and that that reduction in predation will have an impact on survival. So there has been a plan since 1990. It's mostly intended to reduce the squawfish.

I would mention that in this recent PATH report, the scientists that looked at this in-river predation program had some questions about how effective they thought it would be based on their experience in other fields with predation reduction programs.

On marine mammals, NMFS is doing quite a bit of research on the West Coast to look at their dramatic increase. Over the last 20 years we've estimated that between 5 and 7 percent annual increase in marine mammals, mostly Pacific harbor seals and California sea lions. This program is being conducted through the NMFS Northwest Science Center. There will be some more data on that in April of 1999 on what the extent of this predation is on salmon. There's a specific case where we're conducting a cooperative program with the Oregon Department of Fish and Wildlife to look at those California sea lions that are concentrating at the base of the Willamette Falls and seeing what we can do about that specific predation problem there. We're also working on a program tracking and marking California sea lions in the Columbia River to try to determine their origin habits and their movement in the river. On management last year the National Marine Fisheries Service issued a draft report for public comment. One of our recommendations in that report was to support lethal removal of pinnipeds of marine mammals in some of those specific situations where you could identify that they were causing some impact on listed species, and we will have a final report submitted to Congress in 1999 when Congress will begin reauthorization of the Marine Mammal Protection Act.

Part of what I'm saying there is that I think we need some new authorization in order to do the kinds of lethal removal of marine mammals that will be necessary to try to restore salmon.

Senator KEMPTHORNE. Mr. Consenstein, let me, if I may at this point, we will include your statement as part of the record. What I would like to do is go to some questions now so that we can zero in on some of these topics that you've very appropriately raised—I appreciate it.

Mr. CONSENSTEIN. Thank you, Senator.

Senator KEMPTHORNE. With that, Senator Craig, let me call on you for questions that you might have.

Senator CRAIG. Thank you, Mr. Chairman.

Mr. Consenstein, we appreciate your being here today and providing that statement. I have had observers of returning salmon say that there is hardly one that gets to the upper reaches of the Columbia or the Snake system that doesn't have marine mammal bites or scars on it. I don't know if there are any statistics out there to argue that. Are there?

Mr. CONSENSTEIN. Senator, what you're suggesting is that there are interactions between marine mammals and salmon in the Columbia River, and I think that is probably correct. What the scientists are trying to do is try to determine where they are, and once they determine where they are, what we can do about them. The difficulty is if you look at the map that we had earlier of the Columbia River estuary five to eight miles across, as a management problem, it's difficult to just look at that whole estuary and say, well, we should just remove all the marine mammals from the mouth of the river.

Senator CRAIG. I don't think anyone is suggesting that, but there is now substantial evidence that the marine mammals' act to create levels of protection for endangered, or what appear to be becoming endangered animals—seals and sea lions—have worked, and we have also discovered that they breed like rabbits and there are literally great numbers out there that we had never anticipated before. I am told by an observer that there is an island out from Astoria, and this young lady who lives in Astoria says that her grandfather remembered the island being just stacked high with seals and sea lions, and then they, of course, were killed. They went away, and the island vegetated itself, and now that island is a mud wallow again, in essence, and that those mammals lay there in wait of their food source to come swimming into the mouth of the river.

I have a feeling that that is fairly accurate, based on observation and some of the other things I've read and seen, and, of course, the moment we start trying to deal with that law, the television advertisement gets run showing somebody clubbing a seal. Millions of dollars are raised to save the seals and the sea lions, and public opinion comes along and changes political opinion and we don't solve the problem.

So if the National Marine Fisheries is going to be out there looking and making recommendations, my only observation is that you be strong in what you find and you become advocates of it because that is part of a problem. I am not, and I have said it very openly, I am not about to people the people and the economies of Idaho at

risk because we want to make the West Coast the ultimate habitat for seals and sea lions, but there has to be a balance somewhere, and right now it appears to be becoming imbalanced or unbalanced, at least.

You had mentioned while there has been a substantial reduction in harvest in the Snake and Columbia system there is still harvest. In many areas where we list a species we prohibit harvest until it recovers to a certain level, but because of the cultures and the economies built up around the harvest of these fish, we have still allowed it, even as the numbers declined. Why?

Mr. CONSENSTEIN. Senator, the harvest of some of these species occurs in a number of different areas, and we are attempting to address harvest in all of these areas. There is harvest of some of these species out in the high seas fisheries, most of our science shows that there is not a lot of interaction there—there is a negligible amount of harvest.

Senator CRAIG. But is it not also true that in that area of harvest there is a great unknown? I mean, there is a lot that is not known? I was active in stopping the dragnets and a lot of that kind of thing here, and we created that legislative through U.N. efforts, but also knew during that period of time that there were just a lot that wasn't known about that habitat or the take out there.

Mr. CONSENSTEIN. Yes, that's true, and, as a general matter, when we look at the entire life cycle of the salmon, there's not enough research that's been done on the ocean and estuary side of that, and we at NMFS have initiated a major research effort into the ocean and estuaries to try to get—

Senator CRAIG. Well, all of that is known. What we're talking about is those adults that can get to the mouth of the Columbia and begin their journey up toward their spawning grounds, and there they meet a myriad of gill nets and all kinds of take mechanism.

Discuss that with me and with the committee for a moment.

Mr. CONSENSTEIN. Sure, as I said, the high seas fisheries are one area. The first area to consider is the offshore and the fisheries in the deep ocean, and then there's the coastal areas. We can sort of divide those between Alaska and the Pacific Coast along Washington, Oregon, and California, and then Canada, which also takes a significant number of listed species. So there's these different arenas, management arenas, that we have to deal with.

On the Canadian side, we're dealing with that through the U.S. Canada Pacific Salmon Treaty, and, as you may know, it's been a difficult negotiation, but that's where we try to manage that take.

On the U.S. side, there's Alaska and then Washington, Oregon and California. The Washington, Oregon and California side is managed under the Magnuson-Stevens Act through the Pacific Fishery Management Council, and those harvest levels have been reduced significantly in those fishing areas.

For the Alaska fisheries, each species is a little different as to where they actually migrate to. The spring/summer chinook in the Snake River, which is one of those that's most at risk, has a relatively narrow geographic area that it migrates within the ocean, and its ocean fishing has been restricted.

For example, the Alaskans and the Canadians don't take very many of those spring/summer chinook because they don't migrate up there. But to address your question of how harvest is managed in the river, and the management of the harvest in-river is managed through the Columbia River Fish Management Plan, which is a part of the U.S. vs. Oregon settlement. Yearly seasons are set as a result of that fish management plan, and this year the management plan for that in-river fishery did result in a reduction in the incidental take of Snake River steelhead. The plan currently calls for about a 32 percent take, and that's now been reduced to about 10 percent.

Senator CRAIG. For the amount of money that we're spending—and we've spent now well over a billion dollars in the last decade trying to save or find out ways to save these fish. I've often times thought, and others have discussed, why don't we just recognize those who have a legitimate right to take, pay them for a period of a decade, not take any of those fish, let them get to their grounds as best they can to see if we can't build back viable populations along with all the other kinds of things that we're doing.

Has that ever been a point of consideration or is the politics of that just too impossible?

Mr. CONSENSTEIN. I don't know that it's been considered at any real depth, but I've heard that, and I've heard that discussed, particularly for Indian tribes in the region that have treaty rights.

Senator CRAIG. I don't dispute the right to take. What I do dispute at this time—if I'm going to put Idaho through the wringer to save these fish, somebody is going to have to be in the wringer with us, and right now it looks like fewer are than ought to be—at least the end result could be because when we start dumping water out of the Snake River basin, we start drying up irrigation land and putting farmers out of business, and that's what a lot of people want to do. I'm saying, whoa, wait a moment here. We're willing to share in this. Somebody has got to feel a little pain too, and right now I don't think it's widely distributed, or, at least less distributed than it might otherwise be.

Let me ask another question of you, and then I'll give back—I've got several here that I want to ask but time is limited.

Danny, yesterday you and I and the Idaho delegation and Will Stelle, who is here, visited at length about some concerns as it relates to how information gets out and how it gets spun. Specifically we discussed the issue of PATH, and, as I understand, there are models that PATH, the scientific group that's working on the salmon issue now—there are models that they work with to predict recovery successes of the salmon. There's the CRISP model that generally is more of the transportation favoring model, and then there's the FLUSH model that is more of a flow or normative river model.

Now, there is a great deal of work going on at PATH to make these two models more consistent, as I understand, in other words, to better align their output. This, of course, is of great importance because these models could lead to some very serious recommendations for the way the rivers manage for the economic future of the Northwest, and I guess my question is, is the calibration and work

that is done on these models openly shared between any or all people seeking information about those models?

Mr. CONSENSTEIN. Senator, this group called PATH, which is an acronym for Plan for Analyzing and Testing Hypotheses, is composed of 25 different scientists from the Federal Government, State governments, tribes and independent scientists. The group was set up by the National Marine Fisheries Service primarily to try to reconcile those sort of competing models—and I think before we had CRISP and FLUSH, we had even more models. We recognized that was a problem, and that is one of the reasons PATH was organized—to bring the people together to try to share that information in one place, and to dig into the models, see what the assumptions were underlying those models, and see if they could come to some agreement about those assumptions where they were disagreeing.

My understanding is that PATH, this group, and through their facilitator, have done a pretty good job of reconciling those two models. They've gotten closer together. There is less disagreement between the scientists about the models, and the models are coming closer. One example of the models coming closer is that the outputs are coming up with very similar answers.

So I want to stress, though, that these are models. They are computer simulations, and that the PATH process is still very incomplete.

Senator CRAIG. My question, again, is the information created by the models, and the modeling itself, shared to all and is that information available?

Mr. CONSENSTEIN. Yes, it is.

Senator CRAIG. Can you assure me here today that all of that information will be readily available to anyone seeking that information?

Mr. CONSENSTEIN. Yes, sir.

Senator CRAIG. Okay.

The reason I say that is because these models, or the model, may ultimately be used for the basis of making decisions and crafting public policy because we are in search of good science, and if there is not a public process that allows you to assure us the credibility of the model, or the final outcome, then we will risk a problem. It's a problem that you, and I and Will discussed yesterday, along with the delegation. Headlines that have already said in a very premature way, ". . . the science is in. Now, where is the public policy to save the fish?" Well, we know that the science isn't in, but somehow the way it was disseminated, or allowed to be disseminated, and the way it was spun by certain interests and parties caused that to happen. I think it is so damned important that whatever your product is in the end, that it have credibility, and credibility means an open public process for all to criticize, and review or ultimately to come to some level of satisfaction.

I quoted in my opening comments before the Chairman Will Stelle talking with us yesterday, and am I accurate in what I say here, Danny? I quote this as a paraphrase of what Director Stelle said, "The level of uncertainty in the models used by the scientific panel is very high. The conclusions contained in the report are in no way absolute."

Mr. CONSENSTEIN. That is correct, Senator.

Senator CRAIG. "They are merely relative probabilities with wide gaps between what is known and what is not known."

Mr. CONSENSTEIN. That's correct.

Senator CRAIG. So do you see where I'm coming from? If FLUSH and CRISP and their processes, and the informational flow that brings them together is not open and widely available to anyone who seeks it, the end product can get questioned, or spun or shaped outside what it really means.

Well, I thank you for assuring us of that. That is going to be critically important in the coming days. We're going to stay tuned on this with a spotlight on it until the end product appears. We have to do that for all the publics involved, or I think we risk the kind of gaming that occurred last week or week before, and that's just unacceptable to all of us, and I appreciate both you and the Director assuring us that that won't happen again, and that at least between the staffs and the Congressional delegation of the Pacific Northwest we'll have that kind of relationship and credibility that's going to be critical.

Mr. CONSENSTEIN. You have my commitment on that.

Senator CRAIG. Thank you.

Mr. Chairman?

Senator KEMPTHORNE. Senator Craig, thank you. Those were excellent questions and good discussion there.

Mr. Consenstein, again, I appreciate the time that we spent in Oregon and going to Rice Island, the discussion that we had. I know you to be a knowledgeable, dedicated, good public servant of the National Marine Fisheries Service. So I have comments here about the National Marine Fisheries Service that I'm going to make.

Fortunately, or unfortunately, you've been sent as the messenger. I will admit that it seems to me at times that NMFS' focuses more on the populous issues than on the nuts and bolts of trying to get a real solution.

In April of 1997 I wrote to the Administrator of NMFS, Will Stelle, about the way that NMFS had disregarded the consensus proposal on migration and transportation. Six months and many phone calls later when I received no response on what was a very time-sensitive issue, I wrote again, and I finally received a letter but it was too late to change anything. So I'm going to make that letter part of this record.

Several months ago as I began work on the issues we're covering today, I requested current and detailed information on harvest. The NMFS did not respond to my request. Finally, in frustration I wrote a strongly worded letter demanding to know why I was not getting the information. The information finally came 2 days ago—2 days ago, after several months of my having made this request and too late for me to include it in this hearing as part of this discussion. So I'll make that letter part of the record.

In July of this year Dewitt Moss, an Idahoan who is Director of the Northside Canal Company and a member of the prestigious Committee of Nine, wrote a detailed and a thoughtful 12-page letter on the very issues that we're covering here today. Yesterday, the law firm representing Mr. Moss informed me that the National

Marine Fisheries Service has not bothered to answer his letter, and so I will make his letter part of this record.

So I am puzzled—in fact, I am frustrated at this manner in which your agency treats myself, this committee, the citizens. I want you to take back to your agency one very clear message, and that is we will never have a solution to the problems of recovery of salmon and steelhead unless NMFS begins to include the States, and the tribes and the people of the Northwest in the solution instead of treating them like outsiders.

I want it to be clear to your Administrator, your Assistant Secretary and your Secretary that NMFS has done a very, very disappointing job on managing these issues. I regret that I have to give you the message, but you've been sent as the messenger. I think that my comments would be echoed by a number of people, and we are absolutely serious about finding a solution. I think today's hearing has been excellent.

I saw Senator Chafee, again, the Chairman of the Environment and Public Works Committee, and he said, "What an outstanding hearing. I couldn't believe some of the information—that's new information." Well, again, if we can get this information out on the table in a deliberative fashion, then we can find solutions, and I think we're all dedicated to the recovery of salmon steelhead.

Now, let me go to some questions. I referenced this chart, which shows the decline of the salmon runs in the Columbia River. Now, this is the chart that comes from the Corps of Engineers, but let me ask you, Colonel Mogren, is that an accurate depiction showing the declines, and is it also accurate where we've placed the line where the dam—I think it was 1938—was constructed?

Colonel MOGREN. Sir, 1938 is correct. I used this same chart myself in public hearings, and mine has the Bonneville Dam in 1938, so I can't explain the discrepancy there, but it came on line in 1938.

Senator KEMPTHORNE. Again, Colonel, and Mr. Consenstein, I am not embellishing or I'm not creating something, am I, to say that there was a significant decline in the salmon runs before any dam was put on that river?

Colonel MOGREN. Yes, sir, that is correct. This chart shows the estimate at approximately 15–16 million fish per year. There's a lower end to that that runs at about the 8 million line. Most people will discuss 8 to 15 million as where they were backed in the 1860's, and those numbers were back out of cannery production. If you have so many tons of cannery production, you must have had so many pounds of fish to produce that. There was no accurate way of counting the fish before the dam was put in. The Bonneville Dam, when it came on line in 1938, provided a means for counting the fish, and so you see the convergence then along about 1938 when that came about.

You also pointed out, sir, that your lower line there, which was taken from our fish counts where we actually calculate the fish counts, is correct as well. So that leads to the discrepancy between the end point of 2 million now versus the 600,000 that you pointed out, and I'm sorry I don't have an explanation for you. We know we have a general decline from about 1960 out, and it may be that

that decline line comes to the 600,000 point, or, as you pointed out, it's been there all along. I can't explain that right now.

Senator KEMPTHORNE. Okay.

Do you disagree, Mr. Consenstein, with anything that the Corps has said or I have said about that representation of the significant declines in the salmon runs before the dams were put into place?

Mr. CONSENSTEIN. Senator, I'm not going to dispute the data at all. I'm assuming that it is correct data. I would make a comment, though, and this goes back to our discussion earlier about this group, PATH. One of the things that PATH is trying to do is to look at the data going back 20 years, where we have good data, to explain the question: why did this happen and a number of different things happen in those 20 years? Some had to do with the construction of dams, some had to do with hatcheries that went on line at about that same time, some had to do with climate that might have occurred at that time, and other actions. They are trying to come up with an explanation for the decline based on the data, and then to use that to try to project ahead. The models look at this historical data, to tear it apart and tease out the different factors, and then to explain and analyze the effects of certain actions on the future, whether they would be the kind of impacts you want.

So, all I would say is that underlying that data is a lot of different factors. It's not really clear what the cause of the decline was.

Senator KEMPTHORNE. Absolutely.

Colonel?

Colonel MOGREN. Mr. Willis just pointed out something to me that was inherently obvious, and I should have answered in regard to the discrepancies between the lines. That upper line is all returning adults. That includes estimates of what would have been harvested out of the ocean or in the estuary versus what gets counted by the time they get back to the dams. Your lower line of about 600,000 represents an average number of adult fish that made it to the dam.

Senator KEMPTHORNE. Okay.

Colonel MOGREN. The other point I would like to make too, sir, is where that looks like a smooth line, as you've seen with the data you put before, we have very much a spike line. So this is a trend line; it's not a hard count kind of graph.

Senator KEMPTHORNE. That's right.

Mr. Wesley, I want to get your agency on record. Again, is there anything there that you find fault with as far as the data?

Mr. WESLEY. No, I think the data reflects what I know. The only comment that I would make is—and I don't know if it's been done—to go back and correlate any type of habitat modification, timber and production, increased agriculture, significant habitat alteration that would have occurred or potentially occurred during that time. We would have to go back and look at that.

Senator KEMPTHORNE. Sure, okay.

Now, Colonel, let's talk about advanced hydro turbines, fish-friendly turbines.

Fish-friendly turbines, is that an oxymoron? Is this just some scheme that somehow is to mask that we're going to call this new

technology but it doesn't do a darn thing, or is there truth and engineering fact that this thing is going to help save fish?

Colonel MOGREN. Sir, we think the initial information on this is very promising. We would stop short of the whole-hearted moving out to this technology across all the dams at this point in time because it needs to be tested.

One thing we've learned over the process with the dams over the years is that each dam, each project, is unique. It has its own hydraulics and it has its own reaction. Fish react differently to the physical configuration of each dam, and the hydraulics around the dams. And so there are things that we have put into place at one dam that seemed very promising that did not work at another one, as you can see that with the survival rates at each of the different dams. Bonneville has a passage rate of about 87 percent, some of the other dams are as high as 94 to 95 percent, and a layman would ask why? They're all dams, they've all got turbines and all of that. So we think the technology is promising; it's worth studying. We've committed to putting in the turbines at Bonneville as part of that study, as well as an ongoing study with some modeling and so on, and I would just caution to say let's take this a step at a time here to make sure it works as advertised and gets the kind of survivability that's being advertised before we commit to it across-the-board.

Senator KEMPTHORNE. Let me dissect what you just said. "It's worth studying," but part of that study is that you're going to install these turbines.

Colonel MOGREN. Yes, sir, as part of the—

Senator KEMPTHORNE. So this is not just a paper process?

Colonel MOGREN. That is correct. This would be an in-water study.

Senator KEMPTHORNE. How many are you putting in?

Colonel MOGREN. I think we're putting in the whole powerhouse, which is, what, eight units? I think it's eight units.

Senator KEMPTHORNE. Good, excellent.

Mr. CONSENSTEIN. Senator, I would just support what Colonel Mogren said. The National Marine Fisheries Service is very hopeful that this technology will improve juvenile survival through the system. As Colonel Mogren said earlier, there's a team that is composed of a number of Federal agencies, and they work together to try to prioritize projects, and most of the fish scientists, engineers and biologists in the region also agree that this kind of technology should be tested.

But I would also support what Colonel Mogren said about an adaptive management, it's something that we need to do on the entire river on all of these things—on the avian predation, on the improvements to survival to the passage through the hydro system, on the habitat and harvest—all of these things. We need to find ways to make sure that when we try something, we get good information about whether it's working or not, and then kind of go from there because there's so much uncertainty and so many unknowns about what will work that we have to make sure that we design any improvements in such a way that we will get the information we need.

Senator KEMPTHORNE. Okay, Mr. Consenstein, is the Caspian tern an endangered species?

Mr. CONSENSTEIN. I don't believe so.

Senator KEMPTHORNE. Is it a threatened species?

Mr. CONSENSTEIN. I don't think so.

Senator KEMPTHORNE. We know that the salmon and the steelhead are. So can you imagine the frustration of States that may be posed with the question of breaching the dams and the impact that that can have to those States when you have a bird that's consuming the endangered species, upward of perhaps 25 million? I hope the focus is that we will certainly do what is necessary so that those birds are not going to remain on that island and consume those endangered species. I mean, is there any doubt about that?

Mr. CONSENSTEIN. Mr. Chairman, I would say that clearly, as I said, we would like to take this comprehensive approach to solving these problems on the river. Avian predation is clearly one of the problems that we need to address and we intend to do that, but I think we intend to do it with the same approach I just mentioned with the turbines, which is that we need to test hypotheses. We need to see, as Dr. Roby said, whether moving them through the island will work. We are prepared to do that, to relocate them, but we want to ensure that there's enough monitoring, and evaluation to determine if that was effective or not. So I think we just need to caution you that we need to take this action with scientific approval. Uncertainty shouldn't be used as an excuse to not take action.

Senator KEMPTHORNE. Correct.

Mr. CONSENSTEIN. We should take action, but we need to take action that will give us the information we need to determine whether it works or not.

On predation, I would also caution that recently, the scientific review panel that worked on PATH suggested that—and this was with the squaw fish program, specifically—that in their experience with predation control programs around the country they found that there isn't a high level of success and that there's some risk, maybe a small risk, but some risk that it actually would have negative results.

So, again, let me caution you—there is no silver bullet.

Mr. WESLEY. Mr. Chairman, may I comment on that?

Senator KEMPTHORNE. Sure.

Mr. WESLEY. Just as a matter of record, I think that Dr. Roby's study showed that of those fish that are being taken, only about 10 percent of those are the listed stocks. So upward to 90 percent of the fish that are being taken by the terns are probably from hatchery fish.

Mr. CONSENSTEIN. Can I make a comment on that? Our Northwest Science Center is doing some research on using the pit-tags that we were searching for on Rice Island. Our Science Center had a much more sophisticated way of finding the pit-tags. They have a sled that they pulled across the entire area to be scanned, and it could pick up where all these pit-tags were. It just recently went out there shortly after we were there and picked up, I think, about 40,000 signals from pit-tags. There's still some question about

whether some of them were duplicates or not, but they're going to take that data and analyze it to try to determine where they came from, how many of them were hatchery, how many of them were wild, how many of them were different species, and that will give us some more information.

Senator KEMPTHORNE. That's right. But, Mr. Wesley, you said 10 percent? That's millions of smolt, millions, potentially, absolutely.

Mr. WESLEY. Yes, that's right.

Senator KEMPTHORNE. Colonel?

Colonel MOGREN. I just want to make a point on the pit-tag data for the benefit of the record. What the pit-tag does is put a bar code on each fish, and it tells you if it was a barge fish, a wild fish, a hatchery fish, where it passed the dams, and so there's a great deal of data on this that, as Danny said, this skid picked off. I went out there and I watched them do this, and the computer was reading these tags as they went by. There are duplicates there, and the researcher on site said they may only have 20,000 individual tags and maybe higher—we don't know yet.

The point is that this data is still being sorted out, and how many of these are wild fish versus hatchery fish, how many are barged versus non-barged, whatever, that's still a work-in-progress and it will be a while before that data is available.

Senator KEMPTHORNE. Senator Craig?

Senator CRAIG. Mr. Roby, you may want to respond to this, and you can respond from back there if you can speak loud enough.

Both Senator Kempthorne and I have worked very closely with the fish hatcheries, the private fish hatcheries, in the Idaho Hagermen Valley area. We are proud to say that merely 70 percent of retail trout in this country are raised in those fish hatcheries. They have a predation problem. They just simply encased their entire hatchery in a net.

What's wrong with covering Rice Island with a big net and say to the terns, "You can land here, go elsewhere?"

Dr. ROBY. Well, I think you could effectively do that by vegetating it. The birds will choose to go elsewhere—

Senator CRAIG. You could do that in about 3 ½ weeks versus 2 or 3 years of vegetative effort, could you not, and then vegetate underneath the net?

Dr. ROBY. Well, I think you could potentially cover most of Rice Island with an amount of annual vegetation like winter wheat in a fairly short period -

Senator CRAIG. Winter wheat would solve it, you think?

Dr. ROBY. I think it would solve it in the short term. That's what I'm told. I'm not an expert on vegetating materials. I think initially that would be one approach—

Senator CRAIG. We might use Rice Island as a storage area. With the price of wheat right now we could just use that as a storage area.

Thank you because we did solve a problem originally out in Idaho that was viewed as a very expensive thing—it isn't. You create a super structure of not a great deal and you put the nets up, and because the air flows through them, they are not that sensitive to winds and wind storms and all of that, and the pelicans and the sea gulls stop coming inland as much to this ready source of food,

along with everybody else who likes it between raccoons and all of that. I was just curious why that wasn't considered. You want to get an immediate solution to your problem.

Had that ever been talked about, Colonel?

Colonel MOGREN. Sir, we haven't talked about the net option. We have talked about options, as Dr. Roby has said, to discourage the terns from nesting at Rice while encouraging them to nest elsewhere.

I would like to add to that thought here because we've been talking a short-term solution here, and I think it would be a big mistake if we look at this just as a Rice Island problem. As Dr. Roby mentioned, these terns have moved over time from Puget Sound down to Willapa Bay to Grays Harbor to Sand Island and back to Rice Island. So they have a mind of their own, so to speak, and so there is only so much that we can do to influence this. It seems to me that in terms of long-term planning, what we need to do is keep two objectives in mind. We want the tern population healthy and viable, and we want to keep the salmonids from being consumed in the numbers they are now.

So it seems to me that what we ought to be doing is finding a place where we can meet those two objectives, and then manage that for the long-term under a long-term adaptive management plan that keeps the birds there and reduces whatever incentive they have to move elsewhere. Exactly what that plan is yet, we don't have any idea. That is something we're going to have to work through. Maybe Sand Island will be that answer; maybe it won't be, but a sanctuary or refuge or something like that could be appropriate.

Senator CRAIG. I don't dispute that. I understand the importance of long-range approaches. I also understand that we have a bunch of scientists out there jumping up and down saying "We've got an immediate problem. If we can't address it right quickly, we're going to lose some species, we're going to lose some fish, and we may lose entire runs."

Mr. Wesley, you mentioned, as it realties to the graph over there and the decline and changes that were occurring in the area during that period of time, you mentioned timber harvest as one. Between 1900 and 1995 how many millions of people either were born or moved into the Pacific Northwest area that is an immediate habitat area of the fish?

Mr. WESLEY. Senator, I don't know—

Senator CRAIG. The reason I say that is we're always quick to say it was the timber harvest, or it was the farming, or it was the mining, or it was the grazing. Let's talk about people habitat too and the way people transform the land and built hundreds of thousands of acres of suburbia. I'm a little frustrated by that because that's the first to go. We want to stop harvesting of timber in Idaho and we want to do all those things to save the habitat.

Seven years ago our Director of U.S. Fish and Game in Idaho said that 80 percent of Idaho's habitat was intact and relatively pristine—80 percent after 100 years of mining and grazing. So there are a lot of problems out there, and I just wished that we could keep focused on the big ones. I just had to make that comment because I heard timber harvest and didn't hear much else,

but I also know that Portland grew from 1900 to 1995 by hundreds of thousands of people, and, by God, people pollute too.

Mr. WESLEY. Yes, sir, I didn't mean to exclude that and I stand corrected.

Senator CRAIG. Thank you, all right.

Mr. WESLEY. Certainly, urbanization, development of roads, all of that are—

Senator CRAIG. Absolutely, it's the whole problem of the water shed. That's right.

Thank you.

Senator KEMPTHORNE. Mr. Consenstein, let me discuss for a moment further harvest. I heard my colleague, Senator Gorton of Washington, speak on the floor of the Senate recently on the issue of tribal harvest. Would you be willing to bring us up to date on the issue and tell us where we stand with regard to the courts.

Mr. CONSENSTEIN. Senator, I think what you may be asking about the recent court decision by Judge Marsh regarding the Columbia River Fish Management Plan, which is the plan that governs the harvest in the river. That plan determines harvest levels for fishing within the Columbia River. Really the only viable commercial fishery within the river is a predominately tribal fishery on healthy stocks. They are Columbia River chinook, fall chinook. They are not listed; they are basically the Hanford Reach stocks. Hanford Reach is a section of the Columbia River where there's very few impoundments and provides some good spawning and rearing habitat. Those fish that spawn and rear there—the chinook salmon—are fairly healthy. So it would allow harvest on those fish.

The problem is that when they harvest those fish, they also take some incidental take of what's known as the "B-run" steelhead, which are listed.

So as we were negotiating the harvest levels for the healthy chinook stocks, we were trying to limit that harvest and to limit the incidental take of the listed steelhead. Currently, the level allowed in the plan for those listed steelhead is 32 percent. Our biologists had suggested that the population could sustain harvest in the neighborhood of, I think, five to seven percent. Keep in mind we're talking about a run that's only about 2,000 fish returning through the river, so 10 percent is about 200 fish that would be allowed to be taken through this incidental harvest.

We ended up with an agreement with the tribe. Some of the States finally did not agree, but it was a negotiation between tribes, States and the Federal Government over this harvest level. We ended up with an agreement that the target for harvesting the listed steelhead would be 15 percent.

Senator KEMPTHORNE. Let me ask you did the judge order that the tribes stop harvest and the tribes did not stop?

Mr. CONSENSTEIN. No, I don't think that's correct, Senator. What the judge said—the agreement had to go to the judge to get approved under U.S. versus Oregon—was that in order to approve this agreement, NMFS would have to draft a biological opinion to show that this impact would not jeopardize the continued existence of steelhead, and we had not written an actual biological opinion associated with this harvest agreement. So he said that we had to write an opinion. That was basically what the judge's order was.

He would not approve the agreement until a biological opinion was written.

Senator KEMPTHORNE. All right, let me then just as a final question ask with regard to the tern situation and the agreement that you have with the different agencies are we on track to have a solution to that for the 1999 breeding season or what obstacle remains?

Colonel MOGREN. Sir, I think it is fair to say that we are on track for the 1999 breeding season. I have concerns about the long-term management of this issue and long-term planning. That is something that we still have to come to grips with.

Senator KEMPTHORNE. Okay, but short-term for 1999?

Colonel MOGREN. Short-term for 1999, I think we're okay.

Mr. CONSENSTEIN. I agree. I think we're on track. As Senator Chafee said, it's not a lot of money but there's still some money to be found to make sure we've got the funds to do what we need to do, and I'm confident that we will find it. Right now it's not in any particular agency's budget to do it, but I'm confident that we'll find that.

Senator KEMPTHORNE. Mr. Wesley?

Mr. WESLEY. From the Fish and Wildlife Serve, I mean, we recognize the importance of that and the activity that's proposed in working with the group to accomplish that task.

Senator CRAIG. Mr. Chairman, what is the 1999 breeding season on track solution?

Colonel MOGREN. I guess I can take a stab at it generally.

Senator CRAIG. I don't think I heard that. I heard you discussing the potential of seeding some grain out there on the island or cover.

Colonel MOGREN. What we are planning to do, sir, is at Rice Island discourage the nesting to begin with. We will do that by seeding the area and putting in the vegetation to prevent that. At the same time on Sand Island there will be efforts to make that more attractive. The Corps will go out and remove the existing vegetation that's on the island to scarify the land and make it an open sand-type area. We'll have some wildlife folks out there to put decoys out, and I think the phrase was the Caspian terns greatest hits or something like that, but put speaker systems out to attract the birds through sound. That was tested a while back to try to move some of the birds from Rice Island over to East Sands—not East Sands to Miller Sands Island. Now, that's a very small area but it was a successful test. So we're reasonably certain—and that's not a guarantee. We're not making guarantees on this but we're reasonably certain that this can work and help—

Senator CRAIG. I wasn't asking for a guarantee. I was just curious.

Colonel MOGREN. Dr. Roby, if you want to add to that.

Dr. ROBY. I think that's the 1999 goal, to try to move the colony from Rice Island to East Sand Island.

Senator CRAIG. Does a grass or a grain cover truly discourage this bird? Do they like just the plain sand or the unobstructive sand?

Dr. ROBY. They like bare sand substrate. They will nest on bare sand that has scattered vegetation, and that's what in fact they're doing in some parts of the Rice Island colony now, but amount of

vegetation or something that is well established will discourage them. I think that in conjunction with the attractive techniques we use on East Sand island will give us a pretty good likelihood of moving the colony—at least part of it.

Senator CRAIG. Thank you.

Senator KEMPTHORNE. What is our early warning signal that you're not going to accomplish the goal? You said, Danny, that it's not a lot of money. We still have to find some money. There still may be some other things. How do we get notice in time that there's an obstacle toward executing this plan?

Mr. CONSENSTEIN. Senator, I think the first step that we're taking is to follow our legal obligations under NEPA, and the Corps is preparing an environmental assessment, and that is on track but I suppose once a public document is out on the street there could be some reaction to that. If there's problems, that could be one early warning signal, and that's coming out on the street—

Colonel MOGREN. It's the end of this month. The draft is complete. It's a matter of just packaging it.

Senator KEMPTHORNE. Okay.

Mr. CONSENSTEIN. I would say that would be the first one to look for.

Senator KEMPTHORNE. I just think it's very important that we not see a hearing like this 1 year and 2 years where we say, "What a neat idea, and we're going to implement it just as soon as we can." What we want is implement for the 1999 breeding season. No if's, and's or but's. It has to happen.

Mr. CONSENSTEIN. That's our objective as well.

Senator KEMPTHORNE. Okay.

Mr. CONSENSTEIN. Senator, could I just make a comment too about scientific information generally and the response about sharing information?

I completely support what Senator Craig and what Senator Kempthorne said about the need to assure that whatever science information we have is available. It's available to the public; it's available to members of Congress, and I would just like to support that and commit to you that we will be doing our best. I apologize for any gaps in communication that occurred at the staff level in getting your staff that information. I just want to commit to you that we'll try to improve that information flow and just agree with you that we need to get that information.

Senator KEMPTHORNE. I appreciate that because it's been terrible.

Mr. CONSENSTEIN. I'm committing to you that we'll try to make it better.

Senator KEMPTHORNE. I appreciate that.

I'm also going to make part of the record information concerning the Fish and Wildlife Service. I'm going to keep the record open so that if there are some additional questions that any members of the committee or senators would like to ask, we can direct them to you and we would include them in your responses.

But, Colonel Mogren, Mr. Consenstein, Mr. Wesley, Dr. Roby, Mr. Fisher, Dr. Cloud, again, this has been an excellent hearing. I appreciate all of you for your input. Again, I think there's some

real reason for optimism and we can find solutions here, and then execute.

With that, this hearing is adjourned.

[Whereupon, at 12:45 p.m., the subcommittee adjourned, to reconvene at the call of the Chair.]

[Additional statements submitted for the record follow:]

STATEMENT OF HON. RON WYDEN, U.S. SENATOR FROM THE STATE OF OREGON

Mr. Chairman, Oregonians and other Northwest ratepayers have spent billions of dollars to recover Columbia/Snake River salmon. Yet year after year our salmon runs continue to decline. Clearly somebody is doing something wrong.

Congress can't keep going down the same path of spending ratepayer and taxpayer dollars on the tried and failed strategies of the past. We need to try some new, homegrown cooperative approaches.

I have recently applied the cooperative, homegrown approach to problems facing salmon and irrigators. Working with Northwest irrigators and conservation groups, I have developed bipartisan legislation to reduce the threat to salmon and other fish from unscreened water diversions. This initiative was cosponsored by Senator Gordon Smith and has support from all the Northwest irrigation groups and literally dozens of Northwest and national conservation and sport fishing groups, including Natural Resources Defense Council, Oregon Trout, Trout Unlimited, American Rivers, Pacific Coast Federation of Fishermen's Associations, National Audubon Society, and Northwest Sportfishing Industries Association. You don't often see such a diverse set of groups supporting environmental legislation. Save Our Wild Salmon's letter of support states: "Your proposed amendment to WRDA is a true 'win-win' for fish and farmers."

Mr. Chairman, I think you will be particularly interested in what the Idaho Water Users Association, Inc. wrote to you in reference to the Wyden/Smith fish screen amendment: "My purpose in contacting you is to let you know that the Idaho Water Users Association fully supports these amendments and would urge you to do everything in your power to assist in passage of this important provision."

I have attached copies of the Idaho Water Users Association letter and other letters of support for the Wyden/Smith legislation and would ask that you include these in the hearing record.

The problem of fish loss in water diversions is well known in the Pacific Northwest. Juvenile fish, including endangered salmon and bull trout, are killed when they are diverted from rivers and streams along with water used for irrigation purposes. The common-sense solution to this pervasive problem is to safely screen the points of water diversion to allow water through while keeping fish out. Despite existing State and Federal programs to assist with fish screens, unscreened diversions continue to be a significant problem for endangered fish in the Pacific Northwest. The program created by our amendment would help protect endangered fish species by giving the Army Corps of Engineers new authority to work with irrigators to make their water systems safer for fish.

My home State of Oregon has identified fish mortality in diversions as a priority problem. In a letter to Chairman Chafee, Oregon's Governor John Kitzhaber emphasized the importance of this issue to our State. Governor Kitzhaber's letter states: "Oregon is working to restore several runs of fish species and one of our primary goals is to encourage fish screens and passage devices for water diversions on our streams and rivers. . . . Senator Wyden's amendment will greatly benefit the work our local irrigation districts and watershed councils are doing here to conserve and protect our precious fish runs and we urge your very strong support for this program."

To address the problem of unscreened diversions, our State has already developed a cooperative program to assist in screening smaller diversions used on family farms. However, the State cannot afford to provide similar assistance for larger sized diversions. That's where the Federal Government can help.

Thanks to the cooperation of Senator Chafee and his staff, a version of my legislation will be included in the Senate Water Resources Development Act. Under this new program, the Army Corps of Engineers will be able to provide technical planning and design assistance to irrigators to help them make their water systems more fish friendly. This legislation also authorizes the Army Corps to conduct studies on measures to reduce fish mortality on irrigation diversions and what the Federal role is to encourage the use of these measures.

In the future, I will seek to expand this program to authorize the Corps or other Federal Agencies to aid irrigators in actual construction of irrigation diversion improvements.

Mr. Chairman, I'm not claiming that this program is the silver bullet to solve our salmon problem. But this program, along with other programs like the Clean Water bill I introduced earlier this year with Senator Burns are pieces of the complete puzzle, which will be defined by the regional decision framework being developed by Governor Kitzhaber, Senator Smith and others in the Northwest.

Ultimately, it will take the integrated efforts of all interests in our region to recover our salmon successfully. State, Tribal and local governments, local watershed councils, private landowners and the Federal Government will all need to work together. Initiatives like the fish screen amendment will help forge the partnerships upon which successful salmon recovery will be based.

Environmental protection programs developed from the ground up have a much better chance of succeeding than those dictated from Washington, D.C. The people who are directly affected by such programs understand exactly how they will be affected, the goals of the programs, the reasons for striving for those goals and the process by which they are to be achieved. Folks who agree to homegrown solutions do so with their eyes wide open.

The top down approach to environmental protection is, by its very nature, threatening to local citizens and businesses. Only by developing and implementing homegrown solutions will we encourage our citizens, corporations and local governments to make environmental protection an integral part of their day-to-day work.

LETTER FROM IDAHO WATER USERS ASSOCIATION, INC.

Boise, ID, July 20, 1988.

SENATOR DIRK KEMPTHORNE,
U.S. Senate,
Washington, DC 20510.

DEAR SENATOR KEMPTHHORNE: At the present time the U.S. Army Corps of Engineers' Water Resources Development Act (WRDA) is moving through Congress. Section 206 of the Corps' authorities allows them to work with local governments on certain kinds of projects. One of these is fishscreens to protect migrating anadromous fish. In many of the states there are opportunities to protect anadromous fish through installation of fishscreens but because of the present structure of the law, certain entities involved in these diversions are unable to obtain typical services or funding from the Federal Government.

An amendment to me authorization bill titled "The Comprehensive Irrigation Diversion on Ecological Restoration Program" has been suggested by a number of irrigation entities, particularly in Oregon. My purpose for contacting you is to let you know that the Idaho Water Users Association fully supports these amendments and would urge you to do everything in your power to assist in passage of this important provision. As you are well aware, Idaho, Oregon and Washington irrigators are being continually pressed to make improvements that will aid in restoration of northwest salmon stocks. This appears to be a program that could have some rather immediate benefit without significant cost to our districts.

This will be before the committee for markup on Wednesday morning, July 22. Senator Wyden's office has requested a paragraph of approval for the amendment from you and would appreciate your office communicating this to either Martin Kodis or Joshua Sheinkman of Senator Wyden's office.

I appreciate your consideration of this matter and look forward to working with you in the future.

Sincerely yours,

SHERL L. CHAPMAN, *Executive Director.*

LETTER FROM OREGON WATER RESOURCES CONGRESS

Salem, OR, September 8, 1998.

SENATOR RON WYDEN,
Senate Office Building,
Washington, DC 20520–3703.

RE: WRDA AMENDMENTS—Fish Screen Funding

DEAR SENATOR WYDEN: We strongly support the use of the Army Corps Section 206 Local Government Program to be authorized to include fish screens for local

governments in the Northwest states. Providing authority to the Corps will fill some of the gaps left in other programs which are limited to salmon in the mainstem Columbia and Snake Rivers.

Most of Oregon's rivers and tributaries are outside the mainstem of the Columbia and Snake system, but these rivers have listings under the Endangered Species Act for salmon and bull trout, as well. in Oregon there is assistance for screening of diversions for private and corporate interests, but not for municipal corporations such as irrigation districts. This local government program will add one more piece to the overall fishscreen and fish passage program to enable screening of diversions in areas where we have species of concern to protect.

The program is a cost-share program. Water suppliers will be responsible for partial funding and for the long term maintenance. Without effective screening, diverters are at risk for having their diversions halted under the Endangered Species Act provisions.

The Oregon Water Resources Congress (OWRC) represents water suppliers with reservoir operations in Oregon including irrigation and water control districts, other special districts and ports. Our constituents have 99 diversions to be either upgraded or replaced to meet ESA requirements, at an estimated cost of $40.2 million for retrofitting. While the existing screens were designed to meet state and Federal agency requirements when they were installed, technology changes require substantial further investment or replacement to meet current needs.

We promote your interest in addressing public support for public resource benefits. We look forward to passage of the amendment and the ability to work with the Corps to screen or upgrade screening at those diversions deemed a priority for fishery protection.

Sincerely,

JAN LEE, *Executive Director,*
Oregon Water Resources Congress.

LETTER FROM MONTANA WATER RESOURCES ASSOCIATION

Helena, MT, September 9, 1998.

HON. MAX BAUCUS,
Senate Office Building,
Washington, DC 20510.

DEAR SENATOR BAUCUS: ESA listing of Montana Bull Trout and the possibility of others will inevitably add pressure for ensuring enhanced passage and screen protection at water diversion structures. Costs associated with fish screens and passage structures at such facilities would be extreme and certainly a hardship on already financially strained agricultural producers.

A proposed committee amendment to the U.S. Army Corps of Engineers' Water Resources Development Act, sponsored by Senator Wyden of Oregon, would direct more technical and financial assistance toward diversion screening and passage efforts to protect fish, including Bull Trout. The Montana Water Resources Association generally supports the intent of the amendment. We do have concerns and reserver full support pending review and acceptance of final language within the amendment. We have expressed our concerns through the Oregon Water Resources Congress which in working on this issue with Senator Wyden's staff. Primary concerns include: ensuring voluntary participation by all entities, including those controlled by the Bureau of Reclamation, protection of states rights, budget impact on other programs, equitable availability to Montana facilities, and liability following installation.

We urge your careful consideration of this amendment. If we can provide additional information, please don't hesitate to call.

Sincerely

MICHAEL E. MURPHY, *Executive Director,*
Montana Water Resources Association.

LETTER FROM WASHINGTON STATE WATER RESOURCES ASSOCIATION

Yakima, WA 98907, September 10, 1998.

HON. PATTY MURRAY,
U.S. Senate,
Washington, DC 20510.

DEAR SENATOR MURRAY: Amendments to the U.S. Army Corps of Engineers Water Resources Development Act (WRDA) are presently moving through Congress. Amendments to Section 206 of the WRDA will benefit local governments in their efforts to construct fish screens at their facilities. Ultimately, appropriations will be necessary to fund the programs authorized by the fish screening amendment.

The Washington State Water Resources Association represents 97 irrigation districts providing water to over 1 million acres of irrigated agriculture in Washington State. Our members could benefit from the additional screening resources made available by the WRDA amendment. This funding may be particularly useful in the Puget Sound area where funding for fish screens may be lacking.

The amendment, called "The Comprehensive Irrigation Diversion Ecological Restoration Program" has been supported by irrigation entities in Oregon, Montana and Idaho. This amendment provides some Federal funding for fish screens to be utilized by local governments entities that do not presently have access to sufficient funding. We believe that given the present concerns for recovery of anadromous fish species in the Pacific Northwest this amendment is both timely and useful. The amendment will benefit both species recovery and further promote responsible water resource management and thus is deserving of your consideration for support.

Thank you for your kind consideration of our request for support of the WRDA amendment.

Sincerely,

PATRICIA BAILEY, *President.*

LETTER FROM GOVERNOR OF OREGON JOHN A. KITZHABER

OFFICE OF THE GOVERNOR,
Salem, WA, August 17, 1998.

HON. JOHN H. CHAFEE, *Chairman,*
Committee on Environment and Public Works,
United States Senate,
Washington, DC 20510.

DEAR SENATOR CHAFEE: I want to lend my support for an amendment being offered by Senator Ron Wyden to the Water Resources Development Act of 1998 which would provide the Corps of Engineers with the authority to partner with state and local entities in implementing a fish screen program. As you know, Oregon is working to restore several runs of fish species and one of our primary goals is to encourage fish screens and passage devices for water diversions on our streams and rivers.

This amendment would authorize up to $25 million each year for the Corps to develop and implement a comprehensive program that would encourage local irrigation districts to install fish passage devices. The amendment prioritizes fish passage for species listed under the ESA and allows for cost sharing.

Senator Wydens' amendment will greatly benefit the work our local irrigation districts and watershed councils are doing here to conserve and protect our precious fish runs and we urge your strong support for this program.

Thank you for your consideration.

Sincerely,

JOHN A. KITZHABER, M.D.

LETTER FROM SAVE OUR WILD SALMON

Seattle, WA, September 9, 1998.

HON. RON WYDEN,
U.S. Senate,
Washington, DC 20510.

DEAR SENATOR WYDEN: The Save Our Wild Salmon Coalition, which is a coalition of 50 sport and commercial fishing groups, fishing businesses and conservation groups working to restore healthy wild salmon and steelhead runs to the Northwest, supports your efforts to develop a comprehensive program to install fish screens at irrigation diversions throughout the Northwest.

As you know, juvenile and adult fish straying into irrigation systems is a significant source of mortality. Your innovative program to create a voluntary Federal and non-federal partnership to evaluate, design and fund screen installation will protect fisheries throughout Oregon, Washington Idaho and Montana.

Your proposed amendment to WANDA is a true "win-win" for fish and farmers. This effort will not only benefit Salmon and Steelhead, but also Bull Trout, Cutthroat Trout, Redband Trout and many other species of fish. We applaud your efforts.

Sincerely.

PAT FORD, *Executive Director.*

LETTER FROM THE NATIONAL AUDUBON SOCIETY

Washington, DC, September 21, 1998.

HON. JOHN H. CHAFEE,
United States Senate,
Washington, DC 20510.

DEAR SENATOR CHAFEE: National Audubon Society would like to lend our support for an amendment being offered by Senator Ron Wyden to the Water Resources Development Act of 1998 which would provide the Corps of Engineers with the authority to partner with state and local entities in implementing a fish screen program. If the Pacific Northwest is going to be successful in the recovery of their many threatened and endangered salmon stocks, it will take a concerted effort that is fully funded.

We see this amendment, which would authorize up to $25 million each year for the Corps to develop and implement a comprehensive program that would install fish passage devices, as one of many components in a regional salmon recovery strategy.

If we can be of any assistance in the development or implementation of a regional salmon recovery strategy, do not hesitate to contact us. Thank you for your consideration of this matter.

Sincerely,

DANIEL P. BEARD, *Senior Vice President—Public Policy.*

LETTER FROM THE NORTHWEST SPORTFISHING INDUSTRY ASSOCIATION

Oregon City, OR, September 14, 1998.

HON. JOHN H. CHAFEE, *Chairman,*
Committee on Environment and Public Works,
U.S. Senate,
Washington, DC 20510.

DEAR MR. CHAIRMAN: On behalf of the Northwest Sportfishing Industry Association (NSIA), I would like to express our support of the amendment to the Water Resources Development Act (WRDA) proposed by Senator Ron Wyden. We understand the amendment would provide authority for the Army Corps of Engineers to move forward with a comprehensive fish screen and passage program for the Northwest. The volunteer, partnership approach supported by this amendment is consistent with the Oregon Plan for recovery of salmon and steelhead and we ask that you include this amendment as part of the manager's amendment of WRDA for consideration by the full Senate.

NSIA is a trade organization, consists of hundreds of businesses and thousands of family-wage jobs dependent upon our rivers, lakes and streams being healthy and full of fish. Screening of irrigation diversions not only strengthens the ability of endangered fish to survive; it enhances the numbers of healthy populations of fish that sustain our businesses. Screens for diversions prevent tremendous losses of juvenile and adult fish, as well as keeping resident species in the streams where they belong.

It is our understanding that the amendment provides for a sharing of the conservation burden between public and private interests, as it should In addition to requiring cost share for screen installation, the operator is to bear the full costs of maintenance in the future, as well as monitor the screen's efficacy. We have submitted as part of this letter information from an individual with extensive experience with the costs of installation maintenance and monitoring attesting to these costs.

We thank you in advance for your serious consideration and support of the proposed Wyden amendment of WRDA.

Sincerely,

LIZ HAMILTON, *Executive Director.*

ATTACHMENT

NW ENVIRONMENTAL SERVICES,
Oregon City, OR, August 26, 1998.

LIZ HAMILTON, *Executive Director,*
Northwest Sportfishing Industry Association,
Oregon City, OR 97045.

RE: Costs to Maintain Fish Screening Systems

DEAR MS. HAMILTON: You asked if I had any knowledge or estimate of the on going costs to maintain a fish screening system relative to the initial cost to design and construct the system. In my experience, maintenance costs can vary depending upon the size of the venter diversion and type of fish screening system installed. For planning purposes, however, the annual maintenance cost generally ranges from 10–15 percent of the initial project cost. Smaller water diversions would tend to be closer to the 15 percent level and larger diversions would be towards the 10 percent figure.

Maintenance generally falls into one of two categories, either routine or periodic. Routine maintenance includes labor for such activities as visual inspection of the system for proper operation, trash rack cleaning, adjustments of gates or other devices to maintain design water levels and lubrication of moving parts. Routine maintenance can occur as frequently as once or twice per day. Periodic maintenance includes labor and material to repair or replace system components such as screen material, bearings, screen seals, drive train components, etc. Some periodic maintenance is usually done every year and major periodic maintenance is generally done every 5 to 10 years.

My experience with fish screening systems was primarily gained during my tenure as the Fish Screening Program Manager for the Oregon Department of Fish and Wildlife from 1991–1996. During that period of time I had administrative oversight for the construction of several hundred new fish screen systems as well as the operation and maintenance of over 500 existing fish screens throughout the state of Oregon.

Sincerely,

DAVE NICHOLS.

LETTER FROM TROUT UNLIMITED

September 3, 1998.

HON. RON WYDEN,
U.S. Senate,
Washington, DC 20510.

DEAR SENATOR WYDEN: Trout Unlimited, the nation's foremost coldwater fisheries conservation organization, supports your proposed amendment to the Water Resources Development Act to provide for fish screens and the removal of barriers to anadromous and other migratory fish.

As you know, the loss of fish at places where water is taken out of our rivers and streams for agriculture and other purposes is a major factor in the decline of fish species, particularly in the West where irrigation is essential for agriculture. Your amendment to authorize and direct the Corps of Engineers to develop a program for larger diversions is a major step in addressing this problem. We are particularly pleased that language has been included that addresses the problems associated with barriers to migration.

Trout Unlimited greatly appreciates your work on behalf of trout and salmon and other natural resources.

Sincerely,

JEFF CURTIS, *Western Conservation Director.*

LETTER FROM OREGON TROUT

Portland, OR 97204, September 8, 1998.

SENATOR RON WYDEN,
Senate Office Building,
Washington, DC 20510–3703.

RE: Proposed Amendments to WRDA

DEAR SENATOR WYDEN: Oregon Trout and its 4,000 members throughout the region would like to get on the record in support of your proposed amendments to the WRDA that would provide funds for fish screens, passage devices and other measures.

As the state of Oregon has proven in recent years, providing adequate passage and screening for fish is a very worthwhile action that results in saving fish. Unlike many other more questionable public investments on behalf of fish recovery, screens and passage devices do actually work.

Oregon Trout hopes that your proposed amendments to the WRDA are adopted and implemented.

Sincerely,

JIM MYRON, *Conservation Director.*

STATEMENT OF HON. LARRY CRAIG, U.S. SENATOR FROM THE STATE OF IDAHO

Mr. Chairman, thank you for inviting me to participate in this oversight hearing today. A better understanding of the important issues this subcommittee will address this morning is vital to many decisions that lie ahead for all policymakers in the Pacific Northwest.

In this regard, let me state for the record that I, like many Idahoans, was startled last week by the "spin" contained in some newspaper accounts about the recent release of a scientific report allegedly concluding that dam breaching was the only way to save salmon in the Columbia and Snake Rivers. After reviewing the report and discussing it with scientists associated with the development of the report, it is apparent that advocates of dam breaching and some media organizations, simply "jumped the gun."

The chief architects of the report readily acknowledge, indeed highlight, the inherent infirmities with the conclusions of the report. Will Stelle, Regional Director of the National Marine and Fisheries Service, stated just yesterday that—"the level of uncertainty in the models used by the scientific panel is very high"—"the conclusions contained in the report are in no way absolute; they are merely relative probabilities with wide gaps between what is known and what is not known."

These observations underscore the need for further research on matters such as the impact of marine mammal and avian predation on outgoing smelts, the impact of ocean conditions on the salmon, the impact of the release into the ocean of large numbers of hatchery fish along the West Coast, and continued research on hatcheries and genetic resources. Mr. Chairman, thanks to you, several of these issues will be addressed today by this Subcommittee.

To now say that the science on salmon recovery is settled, is to expose either a great ignorance of the complex science associated with salmon recovery or a political bias in favor of the "experiment" of breaching dams. In either case, considering the "tinder box" nature of the salmon debate in the Pacific Northwest, such a statement is destructive and irresponsible.

According to those who have been charged with the difficult task of determining the best science on salmon recovery, there simply is no credible scientific evidence at this time that removal of dams is the sure way to save the salmon. Until such time as the PATH scientists decide they have accumulated all the credible evidence available on this issue, we can not expect scientific conclusions contained in interim reports to be final on the issue of salmon recovery.

In the meantime, responsible parties should show restraint with rhetoric. No responsible person in the Pacific Northwest wants another "Spotted Owl" controversy. The wounds from that controversy, manifest in the form of deep mistrust—both toward government and the environmental community—have yet to fully heal. We all would do well by remaining mindful of that catastrophe.

Mr. Chairman, seeking information in forums such as this, where the public gets an opportunity to see for itself the current state of knowledge on specific salmon issues, is extremely helpful, and certainly goes a long way in helping to dispel mistrust.

I again, thank you for your efforts.

STATEMENT OF HON. GORDON H. SMITH, U.S. SENATOR FROM THE STATE OF OREGON

Mr. Chairman, I appreciate your conducting this oversight hearing on scientific and engineering issues relating to salmon recovery on the Columbia and Snake River system. Given the upcoming 1999 decision on long-term dam operations, the issues before us today are quite timely.

The Columbia River system truly is the lifeblood of the Northwest. The Basin drains approximately 259,000 square miles, and encompasses two countries and seven states in its approximately 1,200 miles to the Pacific Ocean.

In this century, we have harnessed the River for a variety of human activities and benefits, including navigation, water supply, power supply, and flood control. At the time many of the great public works projects in the Basin were constructed, fish and wildlife impacts were fully not considered. We are now struggling with the best way to mitigate these impacts while still meeting human needs. The consequences of these decisions could affect the livelihoods of most Northwest residents.

Today we will hear testimony on scientific and engineering issues concerning harvest, hatcheries and hydropower—three of the four key "H's" of salmon management. Making improvements in each of these areas is essential for salmon recovery. There is no single action that, in and of itself, will recover some of the listed salmon stocks in the Northwest.

I am concerned, however, that a myriad of actions are being required throughout the Northwest in the name of salmon recovery without a recovery plan, an agreement as to what is going to constitute recovery for the various listed species, or adequate monitoring and evaluation to determine the real value of the specific action. Often, there is no defensible biological—justification given for the action being required. Unfortunately, under the current Endangered Species Act, the regulatory agencies don't have to provide such a justification.

As the region attempts to grapple with these issues, we will have to use the best science available to provide a biological basis for the actions under consideration. Certain models are being developed through the PATH process to evaluate the various options for long-term river operations currently being studied by the Army Corps of Engineers. I'm concerned that recent media reports and interest groups have mischaracterized the current status of this process, and also the certainty of any of the conclusions the PATH scientists will eventually be able to draw. It is incumbent on the National Marine Fisheries Service and other Federal agencies to ensure that this analytical tool is accurately characterized, and that its findings are not prematurely assumed.

I look forward to hearing from the witnesses here today on these issues of such vital importance to the region.

LETTER FROM THE FISH AND WILDLIFE SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE,
Portland, Oregon 97232–4181, October 7, 1998.

HON. ROBERT SMITH,
843 E. Main St., Suite 400,
Medford, Oregon 97504.

DEAR CONGRESSMAN SMITH: Thank you for your letter concerning avian predation on Columbia River salmon smolts We appreciate the opportunity to provide you with information on this complex issue.

The Fish and Wildlife Service (Service) is committed to working with the National Marine Fisheries Service (NMFS), which is the dead agency for salmon recovery, to ensure the continued survival of threatened and endangered Columbia River salmon. Although avian predation may be one factor affecting these listed species, we believe that it should not be considered in isolation from the broader context of other potentially more significant sources of smolt mortality such as dams, habitat loss and degradation, harvest, competition with hatchery reared fish, fish transportations and fluctuating ocean conditions. The Service continues to assist NMFS and other agencies to address many of these factors. Since last spring we have been actively working to resolve the unanswered questions concerning the role of avian predation on salmon smolt survival This letter summarizes efforts to address this issue undertaken to date and describes future plans.

Currently, more than 10,000 nesting pairs of Caspian terns breed on Rice Island in the Columbia River estuary. It is the largest known Caspian tern colony in North America and perhaps the largest colony in the world. The birds began nesting on Rice Island in 1987. Rice Island was created by the Amity Corps of Engineers (Corps) in 1962 for the deposit of navigation channel dredge spoils. The island is owned by the States of Oregon and Washington. 1973, the Service began managing Rice Island as part of the National Wildlife Refuge System under an agreement with the State of Oregon. That lease expired in 1994.

In 1995, the NMFS issued a biological opinion to the Corps on the operation of the Federal Columbia River popover system that directed the Corps to conduct studies on Caspian tern predation on juvenile salmonids in the Columbia River. Beginning in 1997, the Corps and the Bonneville Power Administration (BPA) fielded a study conducted by Oregon State University and the Columbia River Inter-Tribal Fish Commission. The first year of this 3-year study has been completed, and the researchers have stated that at least 3 years of data will be needed to accurately measure avian predation on juvenile salmon. Additional work may be necessary to assess the impact of birds on listed stocks.

The first year's report for the avian predation study found that the Caspian terns nesting on Rice Island consumed approximately 6 to 25 million smolts. Clearly, this is a wide range but indicates that avian predation may account for about 3 to 12 percent of the hatchery and wild smolts produced in the basin. Although the percentage of endangered or threatened listed fish consumed by terns is unknown, hatchery reared fish appear to be more susceptible to predation than wild fish. For instance, the higher vulnerability of hatchery smolts to tern predation could be expected as a product of rearing practices that condition young salmon to forage at the surface and otherwise weaken predator avoidance behaviors. Research also indicates that salmon smolts transported by barge or truck, and delayed or stressed by passing through dams, may be subject to higher rates of predation when they enter the estuary. Research is also needed to evaluate the assumption that the fish lost to bird predation would have survived to go into the ocean and return.

As a result of preliminary information from this study, the NMFS, Corps, and Service established a multi-disciplinary team to consider potential management options for reducing avian predation on salmonid smalls while continuing data collection during the 1998 season. In a May 6, 1998 letter to the NMFS and Corps, the Service encouraged development of this interagency team. The Caspian Tem Working Group was established to address these issues and has been meeting regularly since last spring. Representatives from the Corps, NMFS, Service, BPA, USDA Wildlife Services, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Columbia River Inter-Tribal Fish Commission, and the researchers participate in the Caspian Tem Working Group meetings.

The working group has developed a proposal to relocate the terns from Rice Island to East Sand Island, an island closer to the Pacific Ocean, during the 1999 breeding season. This process will use a combination of non-lethal strategies such as habitat enhancement on East Sand Island, tern decoys and tapes of calling terns to lure the birds to East Sand Island, and possibly habitat modification on Rice Island. Preliminary research indicates that terns nesting on East Sand Island mill have a wider variety of prey resources and may subsequently reduce their consumption of salmon smolts. The Corps is in the process of drafting an Environmental Assessment to address the activities associated with relocating the terns. In addition, the working group will develop a monitoring plan and a budget for the proposed management actions The actions were reconfirmed in a September 22, 1998 letter to the Caspian Tern Working Group and signed by the Service, Corps, and NMFS.

The Service recognizes the importance of salmon recovery efforts in the Columbia Basin. We are a continuing participant in discussions on salmon recovery and will continue to play an advisory role with respect to avian predation. The NMFS has the principal responsibility for managing recovery of listed anadromous salmonids, the Corps has responsibility for operating the Columbia River power system and maintaining the Columbia River navigation channel, and USDA Wildlife Services provides expertise in managing problems caused by wildlife. Over organizations that may participate in this effort include the States of Oregon and Washington that own the islands and the Columbia River Inter-Tribal Fish Commission that represent the anadromous fish interests of the Columbia River treaty Tribes.

Sincerely,

THOMAS DWYER, *Acting Regional Director.*

STATEMENT OF HON. CONRAD BURNS, U.S. SENATOR FROM THE STATE OF MONTANA

Thank you Mr. Chairman for the opportunity to address the committee today. It's my pleasure to be here.

Due to my previous visits to this committee, I am sure most realize why Montana has an interest in the problems facing salmon in the Pacific Northwest. It becomes more evident when you look at the current methods used to address the symptoms of the salmon problem. Montanans suffer when water flows are needed downstream to help these weak populations. Our water is taken and our reservoirs are depleted.

The end result is that our native fish species are placed in jeopardy, our recreational activities are curtailed and our tourism industry suffers.

One end result of these draw downs is that we shifted the burden to another fish population, the Montana Bull Trout. As a result, we have had to begin protecting this population under the Endangered Species Act. It is in the best interest of every Montanan, and every person living in the Pacific Northwest, to help salmon populations recover to a sustainable level that will not necessitate passing on harms to other sectors of the environment. It is time we address the problem rather than the symptoms.

Addressing the real problem is harder than many have led us to believe in the past. The finger has consistently been pointed at dams, logging, and other ways of western life. Attacks on these sectors of the economy have proven that they are not the root of the problem. We have found that the problems facing our nation's salmon fisheries are more varied than this and are becoming more critical every year.

This should lead us to realize that past efforts to combat the reduction in our fish populations have sometimes been based more on emotion and quick conclusions than on good, sound science. We are finding out that many of our past reactions to all of the problems facing our environment, including the declining numbers of salmon, have actually made the problem worse or have missed the root of the problem all together.

I believe that it is imperative to continue working towards finding workable solutions to the salmon problem, while understanding that dams and power generation are not enemy number one. Recent strides in technology have enabled us to put turbines into use that negate the impact power generation activities have on the salmon population. Additionally, other mitigation techniques continue to reduce the impact that dam placement has on fish populations.

Even more importantly, recent research and observation of our salmon populations suggest that power generation may actually have a rather small role in the overall challenge facing these populations. Heavy fishing, predation by other species, and other factors deserve equal attention as we look for ways to restore native salmon populations.

I urge this committee to encourage the pursuit of good science and a multi? faceted recovery approach that will address each of the challenges to our salmon without vilifying a specific one without due research. I hope that this effort will address the heart of the problem and allow the burden of restoring the salmon population to be shared more equally among all of the actors involved in creating the current situation. I remind you that the citizens of Montana are the ones who finish the summer with no water in their reservoirs for their own needs, and are faced with a severely declining local fish population, because Montana is absorbing the cost of the current policy based on reacting to the problem rather than finding a solution to the problem.

Mr. Chairman, once again I would like to thank you for this opportunity to express the concerns of my fellow Montanans.

STATEMENT OF HON. HELEN CHENOWETH, U.S. REPRESENTATIVE FROM THE STATE OF WASHINGTON

I want to thank my colleague from Idaho, Chairman Dirk Kempthorne, for the invitation to speak on this very important issue. In the great Northwest fish debate, the stakes are high, especially in Idaho.

As the debate continues to rage—and I believe that a good, honest, public debate is healthy—I am troubled by what appears to be a lost sense of purpose and priorities by our Federal and state agencies, as well as the tribes. It appears that some people are more concerned about style, rather than substance; about agendas, rather than science; and about pre-determined outcomes, rather than considering all factors.

The Implementation Team (IT), the body of representatives of agencies charged with implementing the 1995 Biological Opinion, established the Plan for Analyzing and Testing Hypothesis, known as PATH, which is made up of two dozen scientists.

Just 2 weeks ago, a mere four scientists issued a preliminary, un-peer reviewed report to PATH that comes to absolutely NO conclusions about fish. No recommendations are made. No scientific weight is given. Not enough information was considered. Yet, someone—presumably the agencies—leaked and spun it to the press. What was written about the report in the press, and the facts contained in the report, are worlds apart. No where in the report does it conclude that the dams are responsible for the decline in salmon and steelhead runs—NOWHERE. You

wouldn't know that by reading the press. I compliment the extreme environmental community's "spin-machine." They've made something out of nothing.

Additionally, I have a few concerns about how PATH has operated. If the IT and PATH are to maintain any credibility whatsoever in the fish debate, then it is imperative that PATH utilize and consider all—I mean ALL—available scientific information. Yet, it is my understanding that the PATH facilitator has limited the amount and type of scientific information allowed to be used by PATH working groups.

I've read that the four scientists who issued the PATH report were limited in their consideration of scientific facts. For instance, the computer models relied upon considered only spring chinook; Snake River fall chinook were left out. I also understand that they were not allowed to consider other alternatives, such as changing hatchery practices, or prohibiting commercial harvest, as well as the consideration of predators, spawning bed enhancements and others. If this is true, it is unacceptable. When making a scientific determination, ALL options must be considered; especially when the report is being touted as proving breaching the dams is the only solution.

Mr. Chairman, it is ABSOLUTELY IMPERATIVE that the integrity of the scientists, the scientific evaluation and process be unblemished. When I hear that PATH scientists are unable to consider all relevant data, models and factors, I am troubled. PATH's credibility is at risk. All information must be considered.

Mr. Chairman, there are a few other issues that I'd like to quickly address. As you know, water is the very life-blood of Idaho. It fuels our agricultural based economy. Yet, it is likely that the National Marine Fisheries Service (NMFS) will call for even more Idaho water for flow augmentation in its 1999 Bi-OP.

Study after un-challenged study indicates that flow augmentation does not have any impact on fish return rates. NMFS' own PIT-Tag research shows that there is no correlation between flow augmentation and salmon survival. The State of Idaho's Department of Water Resources says that flow augmentation does not reduce smolt travel time down the river, nor cool the temperature of the water. Drs. Jim Anderson and Darrel Olson's models show no correlation between augmentation and survivability.

So why does NMFS continue down this proven road to failure? Why won't NMFS look at other factors?

It has recently come to light that Rice Island, formed from the Columbia River dredging operations—and I know Mr. Chairman that you've done a lot of work on this—has literally 20 million PIT-Tags on it—10 million from last year alone. Now I'm not a fish biologist, but I have visited Rice Island and toured the BPA hydro system. What I do know is that the PIT-Tags didn't swim onto Rice Island. The smolt are indeed making it past McNary Dam and into the estuary. But they are eaten by the millions by the Caspian tern. Why isn't this being addressed?

In 1994, Congress directed NMFS to report to Congress the impacts of California sea lions and Pacific harbor seals on salmonids. In other words, NMFS is required by law to tell Congress just exactly how many endangered fish are being eaten by protected sea lions and seals. Yet, Congress has never received this report. Again, I am not a marine biologist, but I've seen first hand how the seals and sea lions literally line up to eat their fill of protected, expensive fish. Since Congress has not received this report, I again question whether the science is being shaped to reach a pre-determined outcome. If so, it's unacceptable.

Finally, Mr. Chairman, what about the impacts of commercial and sport harvest? To my knowledge, salmon are the only endangered species that you can hunt. When the taxpayers are asked to spend a billion dollars to save the fish, and when the regions economy is crippled, this is ludicrous.

Recently, NMFS approved yet another commercial salmon harvest on the Columbia River above Bonneville Dam. Tribal gill nets capture thousands of chinook and steelhead only to sell them at one to two dollars per pound to commercial fish buyers. Threatened and endangered chinook and steelhead headed for Idaho are caught along with the Hanford Reach fall chinook. Historically, this fishery has taken 40 percent of the total fall chinook run with large incidental catches of steelhead.

I want to be clear, I do not take issue with tribal cultural and ceremonial salmon harvest seasons that generally occur in the spring, however, this fall chinook gill net harvest is solely commercial. A commercial harvest of endangered fish? This is ludicrous.

I received a letter from Washington State Senator Bob Morton, who is also the Vice President Pro Tempore. He and a colleague, Washington State Rep. Cathy McMorris, flew over the Columbia River to count gill nets. Between Bonneville Dam and McNary Dam, Senator Morton counted 395 gill nets. Without objection, I ask

that his letter be included in the record. Mr. Chairman, this is beyond ludicrous. It is insane.

Until these issues are addressed, it is my position that NMFS has no credibility in this issue.

Chairman Kempthorne, I want to thank you for allowing me this time. I look forward to working with you as Governor next year.

LETTER FOM WASHINGTON STATE SENATOR BOB MORTON

WASHINGTON STATE SENATE,
FFICE OF SENATOR BOB MORTON
Olympia, WA 95804, September 29, 1998

REP HELEN CHENOWETH,
House of Representatives,
Washington, DC 20515.

DEAR HELEN: As we continue to try to ensure that salmon have a future in our state, I believe it is critical for us to consider all aspects of the salmon life cycle. It seems that the focus most recently has been on restoring salmon habitat. While this is a positive step, we must also consider the effects of salmon harvest. How many fish are actually getting upstream to spawning beds?

In pondering this issue, I recently made a visit to the Columbia River. What I saw troubled me such that I arranged a special overflight of the Columbia from McNary Dam to Bonneville Dam. Rep. Cathy McMorris accompanied me on the flight, which was piloted by Gene Cada. We were utterly astounded by the number of gill nets stretched out in the river. I have attached a reach-by-reach quantity of the nets I counted. In total, I saw 395 nets from Bonneville Dam to McNary Dam.

With this many nets catching salmon and other fish on the Columbia River, it seems to me that we need to consider the impact of this fishery on the sustainability of salmon. We need to know how many fish are successful in running the gauntlet of nets once they enter the river system.

How can we truly provide for the recovery of salmon if the river is choked with nets? We simply must consider all factors, of which tribal and non-tribal fisheries are one.

I hope you ponder these startling facts with me and begin to consider what we must do to truly save salmon.

Cordially yours,

BOB MORTON, *State Senator.*

ATTACHMENT

Tribal Fish Gill Net Count—McNary Dam to Bonneville on Columbia River

130 Miles of River
September 2, 1998

	Washington State	Oregon	Total
McNary Dam to Arlington	4	0	4
Arlington to John Day Dam	58	50	108
John Day Dam to the Dalles Dam	64	54	118
The Dalles Dam to White Salmon Bridge	45	38	83
White Salmon Bridge to Cascade Locks/Bonneville	58	24	82
Column Totals	229	116	
Grand Total of Gill Nets			395

STATEMENT OF DANIEL D. ROBY, ASSOCIATE PROFESSOR AND ASSISTANT UNIT LEADER, OREGON COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT,

U.S. Geological Survey-Biological Resources Division, and Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR

Virtually every evolutionarily significant unit (ESU) of anadromous salmonid (Oncorhynchus spp.) in the Columbia River Basin is currently or soon will be listed

under the Endangered Species Act of 1973. Colonial waterbirds (i.e., terns, cormorants, and gulls) may be important predators on juvenile salmonids in the lower Columbia River. Consequently, the Oregon Cooperative Fish and Wildlife Research Unit at Oregon State University and the Columbia River Inter-Tribal Fish Commission initiated a study in 1997 to assess the impacts of fish-eating birds on the survival of juvenile salmonids in the Columbia Basin during out-migration. The objectives of this study were to (1) estimate the size of fish-eating waterbird colonies in the lower Columbia River and determine population trends, (2) estimate the number of juvenile salmonids consumed by these populations, (3) identify the factors that influence avian predation rates on smelts, and (4) recommend ways to reduce avian predation on smelts, if warranted by the study results.

There were nine major colonies of fish-eating birds that nested on islands in the lower Columbia River during the 1997 and 1998 breeding seasons. Most of these island colony sites are unnatural, created by either the dumping of dredge material or rising water levels associated with mainstem dam impoundments. Population censuses indicated that the number of fish-eating colonial waterbirds totaled about 170,000 individuals, a substantial increase over previous estimates (Table 1).

Rice Island, a dredge material disposal island in the Columbia River estuary (Figure 2), supported the largest known Caspian tern (Sterna caspia) colony in North America (over 16,000 birds in 1997), which had grown by over 600 percent since the colony originated in 1987. In 1998, the tern colony had increased by about 25 percent over 1997 estimates to cat 20,000 birds. Nesting success at the Rice Island Caspian tern colony was only cat 5 percent in 1997, due mostly to predation on eggs and chicks by glaucous-winged/western gulls (Laws glaucescens X L. occidentalis). In contrast, nesting success in 1998 was ca. 40 percent.

Two colonies of double-crested cormorants (Phalacrocorax auritus) at East Sand Island and Rice Island in the estuary (Figure 2) are the first and second largest on the entire Pacific coast of the U.S. and Canada and also appear to be growing. The nesting period for these colonies (mid-April to mid-July) generally coincides with the period of smolt out-migration.

Diet analysis indicated that juvenile salmonids were an important part of the diet of fish-eating colonial waterbirds in the Columbia River estuary (Table 6). Caspian terns appeared to be most dependent on salmonids (ca. 75 percent of the diet), followed by double-crested cormorants (ca. 24 percent of the diet) and glaucous-winged/western gull hybrids (ca. 11 percent of the diet). The large California and ring-billed gull (Laws californicus and L. delawarensis) colonies up-river relied less on juvenile salmonids as a food source compared to fish-eating waterbirds in the estuary (Table 6), perhaps due to measures implemented at Columbia River dams to reduce bird predation.

Juvenile salmonids were especially prevalent in the diets of fish-eating waterbirds in the Columbia River estuary during May (Figure 7). Steelhead smolts were most prevalent in Caspian tern diets during early May, followed by coho smolts in late May—early June, and then chinook smolts in late June—late July (Figure 8).

Over 2,000 salmonid smolt PIT tags were found on the Rice Island Caspian tern colony by visually searching, and we estimated that over 30,000 PIT tags have been deposited there over the last 9 years. The recovered PIT tags indicate that steelhead smolts were consumed in greater proportion to availability than other salmonid species, and that juvenile salmonids of hatchery origin were consumed in greater proportion to availability than wild smolts (Figure 11).

We used a bioenergetics modeling approach to estimate the numbers of juvenile salmonids consumed by the Rice Island Caspian tern colony in 1997 (Figure 3). Model-based estimates were that 6—25 million juvenile salmonids were consumed by Caspian terns, or approximately 6—25 percent of the estimated 100 million out? migrating smolts that reached the estuary in 1997 (Tables 14 and 16). Preliminary analyses suggest that the number of juvenile salmonids consumed by Rice Island Caspian terns in 1998 was 8—30 million, an increase over 1997. In addition, preliminary estimates of the number of juvenile salmonids lost to cormorants and gulls in the estuary are in the millions.

The magnitude of Caspian tern predation on juvenile salmonids in the Columbia River estuary has been cause for considerable surprise and concern among fisheries and wildlife managers in the Pacific Northwest. How could losses of smolts to birds, especially to one species of fish-eating bird nesting in one colony in the Columbia River estuary, be so high? Is this level of avian predation the norm, or does it represent an aberrant situation reflecting a highly perturbed ecosystem? We think there are four observations that relate to the current situation. First, the Columbia River estuary has experienced declines of forage fish stocks that would, under other circumstances, provide alternative prey for fish-eating birds such as terns. Second, most of the salmonids consumed by Caspian terns at the Rice Island colony were

raised in hatcheries, and the proportion of hatchery-raised smolts in the diet of terns exceeds what would be expected based on availability. Third, juvenile salmonids that survive the out-migration to the estuary most negotiate dams, slack water impoundments, and other obstacles in their efforts to reach the sea. The cumulative stress associated with this migration likely enhances their vulnerability to tern predation. Finally, the Caspian tern colony on Rice Island is now the only known colony of its kind along the coast of Oregon and Washington, and Rice Island represents one of the few, if not the only suitable nesting habitat for this species along the coast of the Pacific Northwest. This mega-colony has coalesced at Rice Island because there are few other options.

One of our research objectives for 1998 field season was to test the feasibility of potential methods to reduce predation on smelts by Caspian terns, including translocating the colony to a previous colony site on East Sand Island, close to the mouth of the Columbia River. Results from the 1998 field season suggest that moving the Caspian tern breeding colony from Rice Island to East Sand Island may be an effective method to mitigate losses of smalls to terns in the estuary.

East Sand Island is about 13 miles down-river from Rice Island and 6 miles up-river of the mouth of the Columbia River. A greater diversity of forage fishes are available to fish-eating birds in the vicinity of East Sand Island compared to Rice Island. In 1998, double-crested cormorants nesting on East Sand Island consumed a much smaller proportion of juvenile salmonids (ca. 10 percent) than cormorants nesting on Rice Island (ca. 55 percent). Caspian terns in the estuary foraged mostly within five miles of the breeding colony at Rice Island, and 90 percent foraged within 13 miles of the colony. Attempts in 1998 to attract Caspian terns to nest at a new site in the estuary (Miller Sands) using decoys and an audio playback system were successful. Finally, Caspian terns formerly nested on East Sand Island in the mid-1980's, and still frequently roost on the island.

These research results suggest that translocating the Caspian tern colony from Rice Island to East Sand Island is a feasible short-term management option for reducing tern predation on juvenile salmonids. Longer term management may include attracting portions of the current Rice Island Caspian tern population to nest outside the Columbia River estuary. Caspian tern colonies that formerly existed in Willapa Bay, Grays Harbor, and Puget Sound in the State of Washington are no longer extant, and there is evidence that these former colonies have coalesced to form the very large Rice Island colony. Re-establishing these colonies may provide considerable benefits for salmon restoration in the Columbia River Basin and reduce the vulnerability of the tern population to catastrophic events, like oil spills. Management action focusing on tern predation in the estuary may be an effective and efficient component of a comprehensive plan to restore salmon to the Columbia River Basin.

The Interagency Avian Predation Working Group, which includes representatives from the U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Bonneville Power Administration, Columbia River Inter-Tribal Fish Commission, Oregon State University, USGS-Biological Resources Division, and USDA-Wildlife Services, was formed in May 1998 to develop a plan for mitigating the impact of avian predation on juvenile salmonids in the lower Columbia River. At a recent meeting of the Working Group, it was decided to proceed with plans to attempt to relocate the Rice Island Caspian tern colony to a former tern colony site on East Sand Island. This would involve a combination of efforts to attract the terns to nest on East Sand Island and dissuade them from nesting on Rice Island. The former would consist of (1) habitat modification on a portion of East Sand Island to provide the bare sand nesting habitat preferred by terns, (2) placing several hundred Caspian tern decoys on the new colony site to attract terns to land, (3) setting up several audio playback systems on the new colony site to simulate the acoustic environment of a tern colony, and (4) assure that avian predators (gulls, crows) are prevented from disrupting early attempts by terns to breed at the new site. Efforts to dissuade terns from nesting at their current colony site on Rice Island will probably consist of vegetating the current site so that bare sand substrate is no longer available. If this approach fails, additional efforts to move the colony may consist of attracting natural predators (e.g., eagles, gulls, crows) or harassing the terns as they roost on Rice Island at night, prior to the initiation of egg-laying.

Responsibilities of the different agencies in implementing a plan to reduce avian predation in FY 99 have been discussed and agreed upon, both at the Executive-level and within the Working Group. The Oregon State University/Columbia River Inter-Tribal Fish Commission research team will (1) coordinate the efforts to attract the terns to East Sand Island, (2) conduct the monitoring and evaluation to deter-

mine the efficacy of management in reducing tern predation on smelts, (3) test the feasibility of other potential management actions to further reduce tern predation on juvenile salmonids (e.g., bird deterrent devices in foraging areas), and (4) continue to monitor other avian predator populations that may be targeted for management in the near future. To complete the M and E tasks assigned to the research team in FY 99, we will need an additional $204,000 beyond what has already been tentatively approved for funding by the Northwest Power Planning Council. The additional funding is needed to (1) conduct a radio telemetry study as part of the monitoring and evaluation of the management of the Rice Island tern colony, (2) conduct necessary repairs to project boats, and (3) cover the additional personnel costs needed to complete the work. In addition, $50,000 will be required to create Caspian tern nesting habitat on East Sand Island, $32,000 will be required to attract the tern colony to nest on this new habitat on East Sand Island, and at least $60,000 will be required to vegetate the current tern colony site on Rice Island.

The proposed management action of translocating the Rice Island Caspian tern colony to East Sand Island has the potential to save 3—12 million smelts that have reached the estuary and would otherwise have been consumed by terns. Monitoring and evaluation of that plan is critical for adaptive management of the problem. For example, if radio telemetry tells us that terns continue to forage at up-river locations, we can quickly identify foraging hot spots for avian predators that can be managed in season, if necessary.

It is unclear that any alternative sources of funding may be available in time to order needed equipment and supplies necessary for translocation of the Caspian tern colony to East Sand Island or for radio telemetry of terns nesting on East Sand Island, crucial to the monitoring and evaluation of the management action. We ask the committee for assistance in identifying additional potential sources of support for effecting the translocation of the Caspian tern colony ($142,000) and for the monitoring and evaluation ($204,000) of management initiatives aimed at reducing losses of juvenile salmonids to birds in the Columbia River estuary.

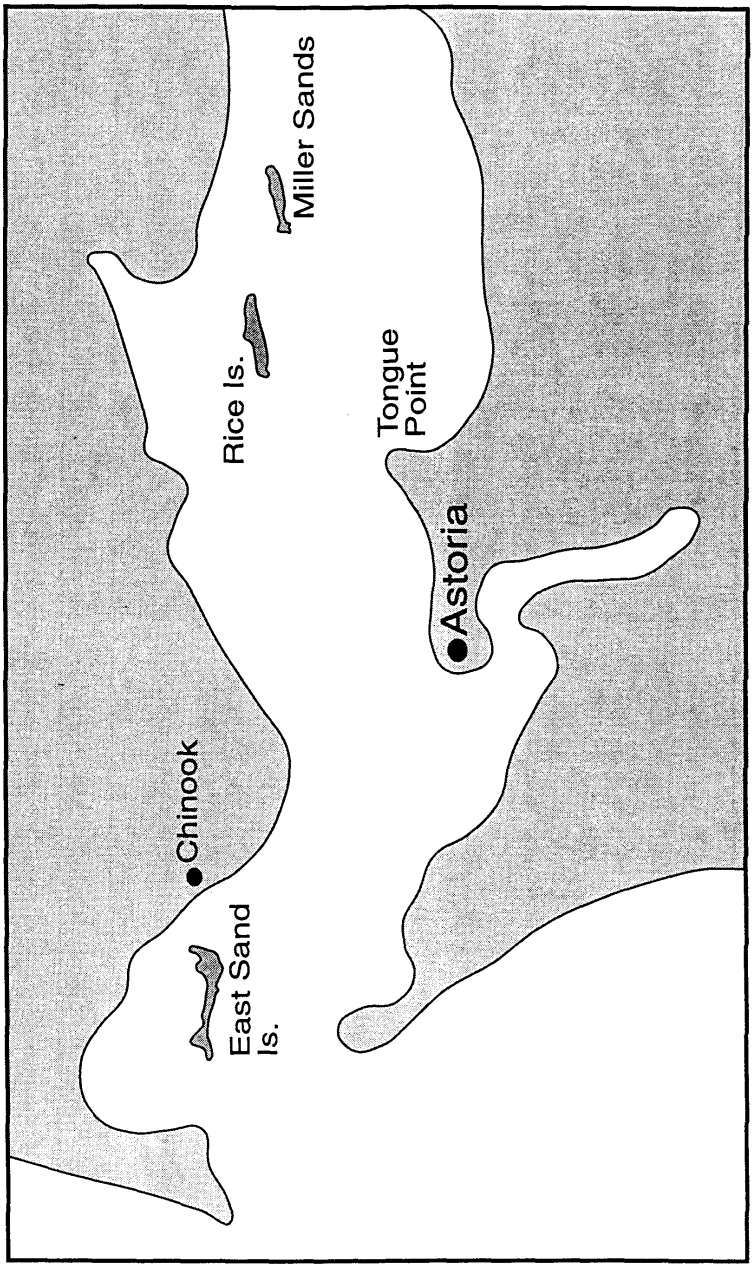

Figure 2. Columbia River Estuary study area and island locations of piscivorous waterbird colonies.

Table 6. Percent mass (mass of prey type/total diet mass) and percent of prey items (number of prey items per prey type/total number of prey items) for piscivorous waterbirds nesting on the lower Columbia River in 1997.

	Estuary Colonies								Upriver Colonies			
	Double-crested cormorant		Caspian tern		Glaucous-winged/ western gull		Ring-billed gull		California gull		Ring-billed gull	
Prey Type	% Mass	% No.	% Mass	% No.	% Mass	% No.	% Mass	% No.	% Mass	% No.	% Mass	% No.
Crustacean	--	--	--	--	0.1	0.6	--	--	--	0.2	0.0	0.2
Mollusk	--	--	--	--	4.1	34.3	50.7	69.4	14.7	57.9	7.9	15.2
Insect	--	--	--	--	0.1	12.7	--	--	6.3	37.4	10.2	84.1
Vertebrate	--	--	--	--	0.2	0.6	--	--	18.6	2.5	8.6	0.5
Plant Material	--	--	--	--	0.5	--	5.2	na	17.4	na	36.4	na
Refuse	--	--	--	--	12.2	na	--	--	27.4	na	36.8	na
Fish	100.0	--	100.0	--	82.7	--	44.1	--	14.3	--	0.0	--
Pacific Lamprey[1]	0.1	0.4	--	--	--	--	--	--	--	--	--	--
White Sturgeon[2]	3.7	0.4	--	--	--	0.6	--	--	--	--	--	--
Pacific Herring[3]	0.5	0.2	--	--	--	--	--	0.1	--	--	--	--
Peamouth[4]	32.9	15.8	15.8	7.4	10.4	1.8	7.4	1.2	4.9	0.3	--	--
No. Pikeminnow[5]	1.6	1.1	--	--	--	--	--	--	0.2	0.2	--	--
Unident. Cyprinid[6]	--	0.4	--	--	--	--	--	--	--	--	--	--
Sucker[7]	8.1	2.3	--	--	7.1	0.6	--	--	--	--	--	--
Smelt[8]	0.1	0.9	--	--	--	--	--	--	--	--	--	--
Salmonid[9]	**23.7**	**30.3**	**74.5**	**84.5**	**10.8**	**10.8**	**0.5**	**0.1**	**6.0**	**1.1**	**0.0**	**0**
Stickleback[10]	1.6	21.2	--	0.1	0.5	9.6	2.9	3.5	--	--	--	--
Sculpin[11]	6.0	13.5	--	1.3	3.7	1.2	3.7	23.5	1.9	0.5	--	--
Shiner Perch[12]	3.5	8.6	1.7	1.3	--	--	--	--	--	--	--	--
Starry Flounder[13]	1.5	3.0	0.7	3.9	9.5	25.9	9.5	--	--	--	--	--
Other	1.2	1.9	--	0.1	7.2	1.2	7.2	--	--	0.2	--	--
Unknown fish	15.5	na	7.3	na	33.5	na	18.9	na	1.2	na	--	--
Samples Examined	154		92		80		23		156		53	
Total Mass and No.	10,637 g	532	3,893 g	155	1,470 g	166	195 g	170	2,586 g	653	874 g	592

[1]*Lampetra tridentata*, [2]*Acipenser transmontanus*, [3]*Clupea pallasi*, [4]*Mylocheilus caurinus*, [5]*Ptychocheilus oregonensis*, [6]Cyprinidae, [7]Catostomidae, [8]Osmeridae, [9]*Oncorhynchus sp.*, [10]Gasterosteidae, [11]Cottidae, [12]*Cymatogaster aggregata*, [13]*Platichthys stellatus*

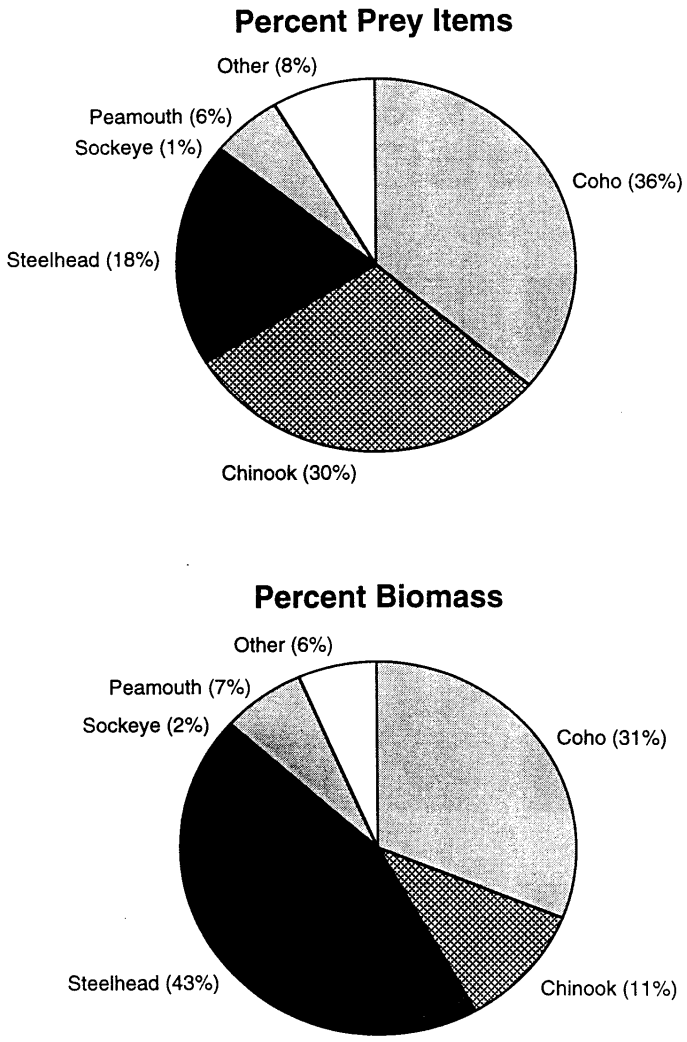

Figure 7. Percent prey items and biomass in the diet of Caspian terns based on the collection of dropped fish in 1997. Analysis based on a total sample size of 119 dropped fish.

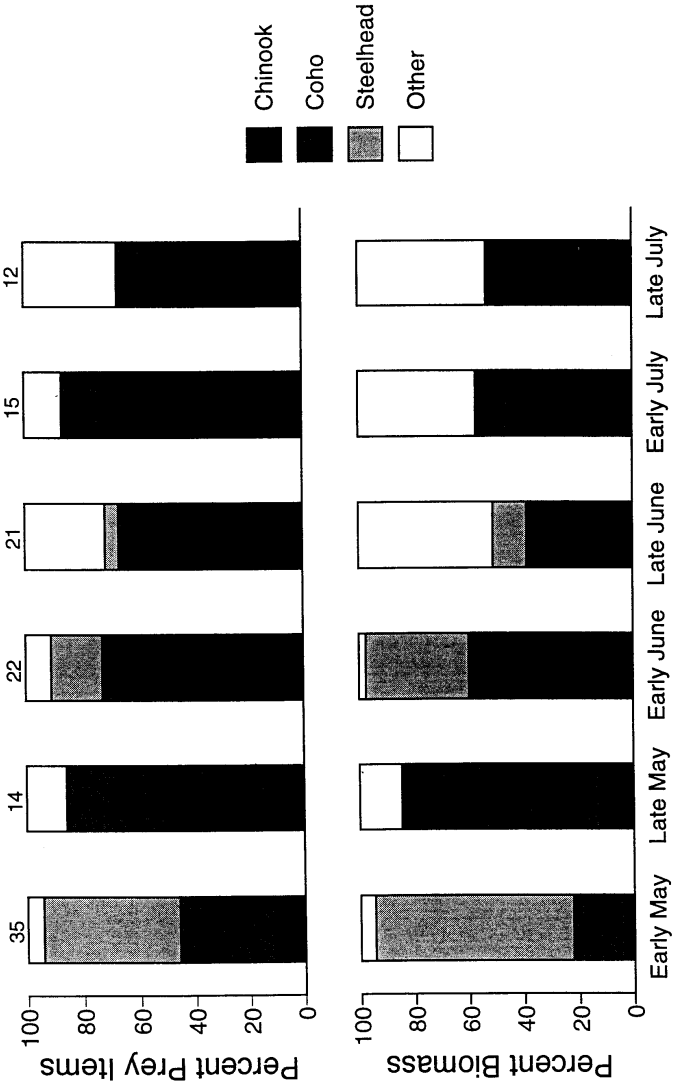

Figure 8. Percent prey items and biomass in the diet of Caspian terns by month based on the collection of dropped fish in 1997. Number of dropped fish in the sample are given over each bar.

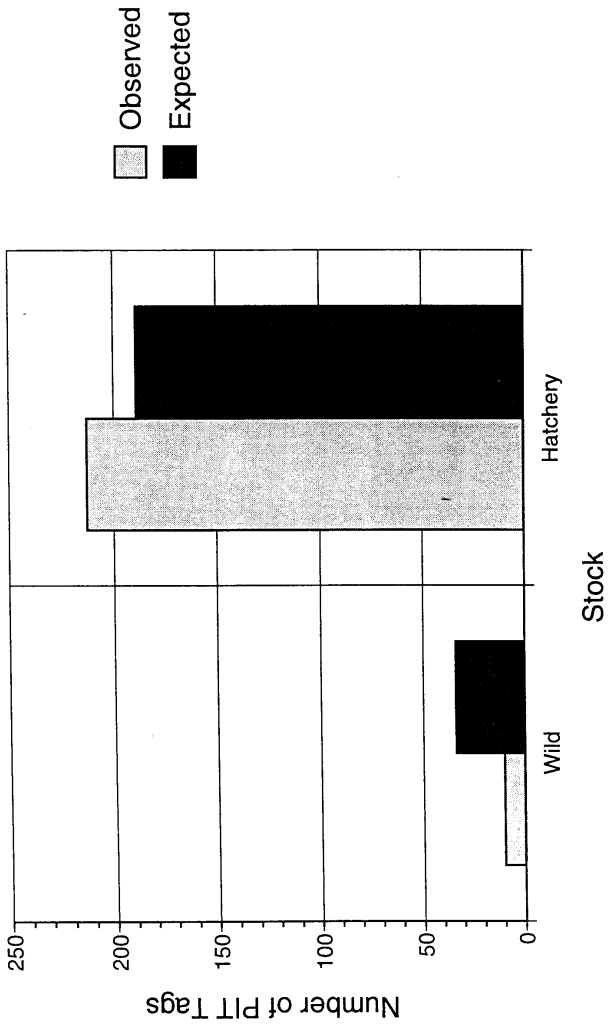

Figure 11. Relative vulnerability of PIT-tagged wild versus hatchery salmonid stocks to predation by Caspian terns nesting on Rice Island in 1996. Observed values were the number of PIT tags from fish of each rearing type recovered on the colony from the 1996 migration year. The expected values were derived from the relative proportion of PIT-tagged hatchery verses wild salmonid stocks interrogated in-river at Jones Beach in the Columbia River estuary (Ledgerwood et al. 1997).

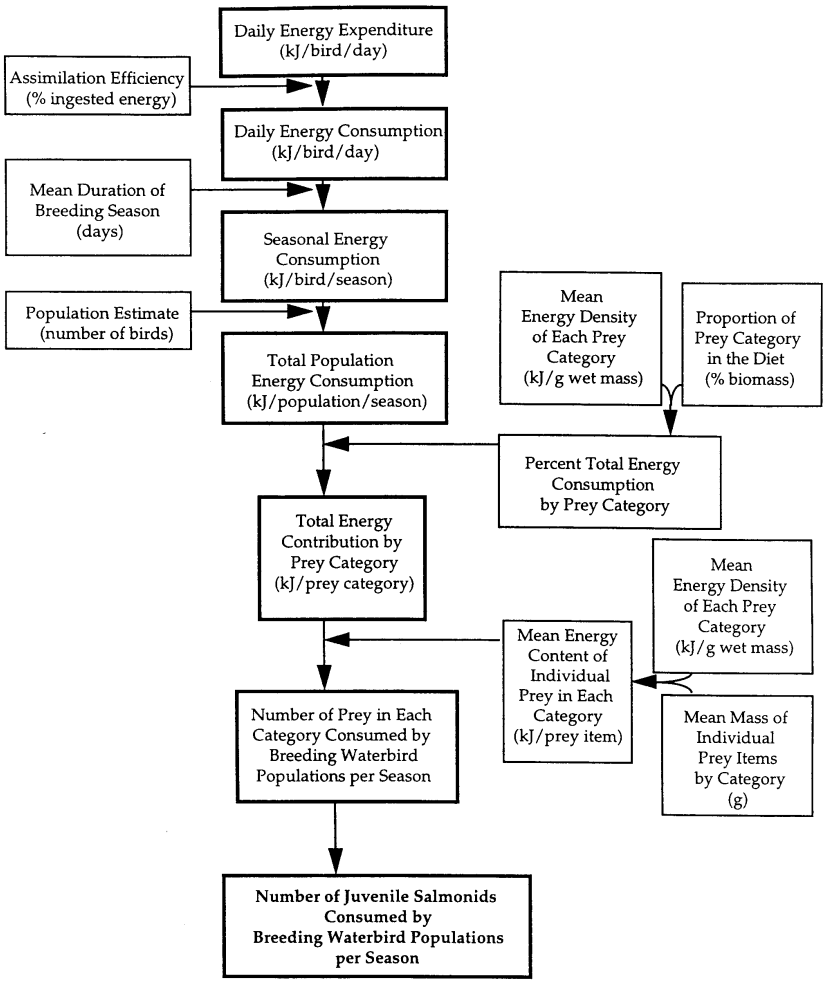

Figure 3. A bioenergetics model for estimating the number of juvenile salmonids consumed by colonial waterbirds in the lower Columbia River.

Table 14. Input parameters of a bioenergetics model for estimating the total population energy consumption of Caspian terns breeding on Rice Island in 1997.

	Maximum	Best	Minimum
Daily Energy Expenditure (kJ $bird^{-1}$ day^{-1}) [a]	1,138[b]	907[c]	736[d]
Assimilation Efficiencies	0.70	0.75	0.80
Daily Energy Consumption (kJ day^{-1})	1,626	1,209	920
Average Duration of Predation (days)	100	90	80
Seasonal Energy Consumption (kJ)	162,570	108,810	73,600
Population Size (individuals)	18,830	16,034	13,746
Total Population Energy Consumption (kJ)	3.061×10^9	1.745×10^9	1.012×10^9

[a] Daily energy expenditure estimated on the basis of an average Caspian tern body mass of 654 g (unpubl. data, this study) and the allometric equations (Birt-Friesen et al. 1989) for:
[b] seabirds using flapping flight
[c] all seabirds
[d] seabirds using non-flapping flight

Table 16. Estimates of the number of prey consumed by Caspian terns nesting at Rice Island in 1997 using the bioenergetics modeling approach.

	Fish from Bill Loads[a]			Adult Stomach Contents[b]		
	Maximum	Best	Minimum	Maximum	Best	Minimum
Total Juvenile Salmonids	20,211,242	11,392,691	6,643,937	24,715,839	14,540,388	8,479,596
Prey Type						
Salmonids[c]				15,624,762	9,612,642	5,605,856
Steelhead	4,231,029	2,398,634	1,398,825	3,679,203	1,994,009	1,162,857
Coho	8,912,167	5,052,442	2,946,460	3,479,373	1,886,748	1,100,305
Chinook	6,636,981	3,762,605	2,194,259	1,932,499	1,046,988	610,577
Sockeye	315,757	179,007	104,393			
Peamouth	1,451,863	823,084	480,002	3,675,389	1,991,899	1,161,627
Herring	621,669	352,433	205,521			
Sucker	207,526	117,650	68,611			
Sculpin	416,369	236,046	137,657			
Shad	414,163	234,796	136,927	797,974	432,300	252,107
Shiner perch	201,088	113,999	66,481			
Smelt	2,023,884	116,130	67,725			

[a] these estimates of prey consumption are based on estimates of diet composition derived from samples of prey transported in the bills of adult terns.

[b] these estimates of prey consumption are based on estimates of diet composition derived from samples of adult stomach contents.

[c] salmonids that could not be identified to species.

STATEMENT OF JOSEPH CLOUD, PROFESSOR OF ZOOLOGY, DEPARTMENT OF BIOLOGICAL SCIENCES, UNIVERSITY OF IDAHO

Introduction

Good morning Mr. Chairman and members of the committee. My name is Joe Cloud,and I am a faculty member of the University of Idaho and a member of the Washington State University / University of Idaho Reproductive Biology Center. My research expertise is the reproduction and early development of fish with an emphasis on salmonids. My objective in this testimony is to provide you with the rationale for and the feasibility of establishing a germ plasm repository or gene bank for threatened and endangered fishes.

Background

Many fish populations around the world are declining. Some of the causative factors that have contributed to these declines include over-fishing, habitat destruction or degradation, pollution and genetic introgression. Regardless of the causes, a decrease in the size of a population can result in a decrease in the diversity of genes within the population. Because many of the unique characteristics of the various

fish stocks are genetic adaptations to local conditions, the loss of phenotypic characteristics within a population can be detrimental to the long-term survival of the population in its native habitat. Since a number of the causes for the declines in fish populations are due to the activities of the human population, many of the problems that contribute to these declines in fish populations can be corrected, but these corrective actions may require extended periods of time.

In order to reduce or reverse the declines in fish populations, fish hatcheries have been established to mitigate the loss of native spawning habitat and to enhance the reproductive output of fish stocks. Although fish hatcheries have generally been very successful in the production and rearing of fry, the resultant gene pools of the hatchery populations are not always the same as the native stock from which they were derived. Thus, although hatcheries have been an important tool in the enhancement of fish populations, they have some inherent weaknesses relative to the maintenance of the original genetic composition of fish stocks.

Therefore the establishment of germ plasm repositories for fish populations provides (1) a means to reestablish a population when factors that resulted in the population decline are corrected and (2) a backup for the inadvertent change in the genetic makeup of a population with the development of hatchery programs.

Gene Banks for Fish Populations

At present, the cryopreservation of sperm is the only functional means of storing fish germ plasm for extended periods of time. The freezing of sperm, the efficient packaging of semen, and the long-term storage of sperm in liquid nitrogen were initially developed many years ago by scientists to support the genetic improvement in the dairy industry. Using these same technologies coupled with the understanding of the differences between mammalian and fish sperm physiology, cryobiologists around the world have successfully developed protocols to freeze sperm from a wide variety of freshwater and marine species of fish. Given the progress to date, these or similar methodologies can probably be utilized to preserve the spermatozoa of all current fish populations. Additionally, since the storage time for fish sperm held in liquid nitrogen has been estimated to be greater than 200 years, the time scale for the storage period is more than adequate for a germ plasm repository.

The establishment of gene banks for fish populations is not a hypothetical suggestion; it is a program that has a successful track record. This technology has been utilized successfully by a number of different countries in the establishment of fish germ plasm repositories around the world as a component of efforts related to fish genetic conservation. Norway, for example, has initiated an extensive effort to collect and preserve the germ plasm of native Atlantic salmon that spawn in their rivers. In 1986 the Directorate for Nature Management in Norway established a national gene bank program for their native salmon. At present, their repository contains frozen milt from over six thousand individuals from 155 salmon stocks. Although there is no national program in the United States, there are regional programs involved in the collection and cryopreservation of fish sperm. In the Northwest, our laboratory at the University of Idaho in partnership with Washington State University and the Nez Perce Tribe has initiated the development of a gene bank for chinook salmon that spawn in tributaries of the lower Snake River. At present, our efforts have resulted in the cryopreservation of sperm from over 500 males from 12 tributaries. Our efforts were initiated in 1992 and continue to the present. Although our efforts have been limited by funding, we are determined to save at least a portion of the gene pool of these stocks.

The major disadvantage of a gene bank based on frozen sperm is that the reestablishment of an extinct stock requires extensive backcrossing or the use of androgenesis with eggs from a related stock. This problem has a simple solution—preserve both sperm and eggs. However, the cryopreservation of fish eggs, because of their relatively large size, has not been successful to date. Support for research efforts in this area is needed; however, this is a very challenging problem and will not be solved quickly.

Concluding Remarks

It is my belief that the human population has an intrinsic need and responsibility to preserve the genetic legacy of our fish populations. Genetic conservation of existing fish stocks is an important goal in itself, and as a component of programs designed to insure a viable and sustainable fishery under changing environmental conditions. With the constant threat of losing genetic diversity in specific native fish stocks as a result of declining population numbers or as a result of genetic selection pressures in hatcheries, the establishment of a program for the long? term storage of fish germ plasm would serve as a back-up and insurance for the presently ongoing conservation programs.

There is an important caveat in the development of a fish sperm bank. This product is a genetic repository, and as such, it will not solve any population problems of a fish stock that is decreasing, nor will it directly result in more fish in the rivers. What a sperm bank will do is guarantee that the genes, or combination of genes, that make a fish stock unique will not be lost forever.

STATEMENT OF RICHARD K. FISHER, JR., VICE PRESIDENT, TECHNOLOGY, VOITH HYDRO, INC.; ACCOMPANIED BY PATRICK A. MARCH, SENIOR MANAGER, NORRIS ENGINEERING LABORATORY, TVA RESOURCE MANAGEMENT; DILIP MATHUR, PH.D., VICE PRESIDENT, NORMANDEAU ASSOCIATES; FOTIS SOTIROPOULOS, PH.D., ASSISTANT PROFESSOR, GEORGIA INSTITUTE OF TECHNOLOGY; GARY F. FRANKE, SENIOR ENGINEER, VOITH HYDRO, INC.

INTRODUCTION

Environmental concerns broadly affecting the electric power generation industry include the potential for global climatic changes as a result of greenhouse gases produced by combustion, the depletion and disruption of fossil fuel supplies, air and water quality, aquatic life impacts, and uncertainties about long-term nuclear waste management. As a result of these concerns (in many instances stimulated by environmental groups and regulatory agencies), the U.S. electric power industry is focusing attention on technologies for renewable, non-polluting energy generation. Among these, hydroelectric power generation can play a significant role.

By impounding water in reservoirs and harnessing nature's energy through hydroelectric generating plants as a part of the solar water cycle, hydropower provides a renewable, nonpolluting source of energy. Hydropower is by far the largest developed renewable energy resource in the world, supplying about 10 percent of the electricity output in the U.S. and approximately 20 percent of all electricity generated worldwide [1]. In the near term, further development of hydroelectric energy generation potential, through upgrade of existing plants and installation of new facilities, could increase clean energy production and make a near term contribution to the reduction of greenhouse gas emissions [2].

Impoundments and releases from hydropower facilities can, under certain conditions, adversely impact the water quality of impounded and discharged flows as well as the aquatic life upstream, downstream, and migrating through the sites. These impacts have been severe enough to cause political and environmental activists to demand improvements. Today, in the U.S., environmental demands include the release of higher spills from impoundments to increase fish passage survival and even demands for the removal of large dams in some areas of the country, in both cases reducing hydra energy generation.

To address these adverse effects of hydropower facilities, new technologies are emerging which, when applied, can remove many of the negative environmental effects of hydroelectric power generation and enhance the recognition of hydra power as a source of renewable energy. Some of these new developments address the improvement of fish passage survival and the reduction of hydro's impact on both water quality and aquatic habitat. This presentation will discuss work currently underway in the U.S. related to these issues.

Hydroelectric Power Generation

Developing Better Environmental Alternatives

Beginning in the mid-1950's, some operating utilities in the U.S. began to respond to environmental concerns and initiated steps to improve the environmental compatibility of their hydro plants. Two areas of the country were particularly active. In the Pacific Northwest, biologists, governmental agencies, and utilities on the Columbia River were experimenting with ways to increase survival of fish as they passed downstream through hydro plants (Fish passage is now also emerging as an important issue in the eastern U.S.). In the Southeast, the Tennessee Valley Authority (TVA) was a pioneer in utilizing an integrated system approach, finding improved ways to balance the multiple uses of water resource projects among hydro power generation, flood control, municipal and industrial water supply, water quality, and recreation. TVA, adopting a proactive approach to environmental stewardship, has invested significantly in R&D and hardware to develop and implement improvements to system operation that optimize benefits among all stakeholders in their water resource projects [3].

As part of its strategy to be responsive to the needs of its customers, Voith has had a long-term commitment to developing hydro equipment designs with technologies for environmental enhancement. In the 1950's, Voith played a leadership

role in Europe with R&D to develop turbine designs capable of boosting dissolved oxygen (DO) levels in water passing through low head turbines [4]. In the 1970's, their engineers began investigations into the use of greaseless components in turbine power control elements. In the 1980's, Voith continued the development of oil-free Kaplan turbine hub designs with the installation of several "Oil Free" Kaplan turbines and began R&D to improve the understanding of issues leading to the mortality of fish passing through hydro turbines [5, 6]. In this same time frame, Voith Hydro, Inc., invested significant funds with TVA into a joint R&D partnership to develop improved hydro turbine designs to enhance DO concentrations in releases from Francis-type turbines.

In the 1990's, these efforts were further intensified [7]. In 1995, under the stimulus of a cost-shared Department of Energy contract, Voith Hydro, Inc., began an in-depth effort to develop an "Advanced Environmentally Friendly" family of turbine designs, in collaboration with Georgia Institute of Technology, Harza Engineering Co., Normandeau Associates, and the Tennessee Valley Authority. The environmental improvements for the advanced designs addressed the goals of: 1) improving fish passage survival; 2) increasing the levels of dissolved oxygen in hydro plant discharges; 3) developing special turbine designs for efficiently providing minimum stream flows to protect downstream aquatic habitats; and, 4) developing designs to provide reduced oil and grease pollution. These concepts primarily addressed the enhancement of hydropower's environmental compatibility through upgrades of turbines in existing hydro power stations. However, the environmentally improved design concepts also provide added benefits, including improved plant energy generation and reduced operating and maintenance costs, and the concepts are applicable to new turbine installations as well. An independent investigation by the joint venture of Alden Research Laboratory, Inc., and Northern Research and Engineering Corporation, under a second DOE contract, also supported the achievability of "fish friendly" turbines with a unique design that is primarily applicable to fish bypass flow schemes and new turbine installations.

Today, progressive U.S. operating utilities are upgrading turbines to environmentally friendly designs as a part of their programs for relicensing and energy generation improvement. Utilities and water resource agencies are also developing strategies and implementing control systems that improve how they operate their turbines to enhance water quality and fish survival when fish and/or low levels of DO are present. The direct fish mortality of turbine bypass systems, including spillways (which may also add detrimental dissolved nitrogen) and fish collecting structures, are under investigation to provide an understanding of how all of the components of a hydro project can be used to improve its environmental compatibility. In many cases, passing fish through environmentally enhanced turbine designs can result in higher overall survival than bypassing fish through the dam's spillways [8, 9].

This presentation focuses primarily on environmentally advanced turbine and control system designs and technologies that are being developed to increase fish passage survival and improve levels of DO in turbine discharges.

Increasing Fish Passage Survival

By 1990, over 40 years of investigating fish survival by catching fish downstream of turbines had not provided in-depth insights into actual mechanisms affecting fish survival. The turbine had been treated as a "black box" by many researchers, and only vague rules of thumb had been developed to biologically characterize turbines. Statements such as "Turbines are like blenders—they chop and kill a significant portion of passing fish," "Kaplan turbines are more fish friendly than Francis turbines," and "Operation at best efficiency is best for survival" were used regularly to characterize hydra turbines. Beginning in 1990, a more precise method for measuring fish passage survival was introduced. This technique uses carefully designed and controlled testing with fish which can be recovered with "balloon tags" [10]. Based on the results of those experiments, statistical characterizations demonstrating much higher fish survival began to emerge [11]. Survival rates, measured for fish passing directly through large turbines, ranged from 88 to 94 percent.

In the past 5 years, important research aimed at further understanding the mechanisms leading to fish mortality has been completed. Numerous workshops bringing biologists, operators, regulators, and designers together to exchange views have improved insight into factors which may influence survival. The US Department of Energy's (DOE) Advanced Hydro Turbine (AHT) program further stimulated an in-depth investigation into mechanisms for fish passage mortality through the use of detailed numerical simulation of fluid flows in turbines with 3-D viscous computational fluid dynamics (CFD) methods and careful balloon tag testing. As a result of the studies, turbine design improvements which can be implemented in new ma-

chines or through rehabilitation of existing machines have been developed [12]. Limited field testing to date has verified many of the conclusions reached [13, 14]. An especially enlightening test of the existing turbines at Wanapum Dam using balloon tagged fish verified many of the fish mortality mechanism models [15, 16] and showed that best efficiency operation of Kaplan turbines is not necessarily the most favorable operating condition for fish survival as was previously believed. Instead, operation at higher flows was found to be safer for passing fish (Figure 2). The research developed insights into mortality mechanisms for Kaplan turbines, with mortality being related to: turbulent flows resulting from low efficiency designs or plant operating strategies; turbulent flows and the trapping and cutting of fish in the zone of flow passing near the turbine hub when large gaps between blade and hub exist (characterizing the lower output operation of Kaplan turbines); strike of fish by turbine blades or impact of fish on other turbine structures; cavitation in turbine water passages; abrasion of fish driven into rough turbine surfaces by flow turbulence; and even turbulence-induced or impact-induced dizziness enhancing the chance for predation losses as disoriented migrating fish are eaten by birds or other fish when they emerge from the draft tube. The number of turbine runner blades and stay vanes, the length of the fish compared to the size of the turbine, and the quality of the flow at the point of operation are key elements that characterize survival [12, 16]. Also, the location of the fish in the water column and the zones of flow through which the fish pass are observed to be important.

As a result of insights gained, a comprehensive environmentally enhanced Kaplan turbine concept was developed. The required features depend on site specific goals and include designs having: 1) high efficiency over a wide operating range with reduced cavitation potential (results from today's advanced technology design verification tools); 2) a gapless design for hub, discharge ring, and blades (Figure 3) that enhances fish passage survival; 3) a non-overhanging design for wicket gates; environmentally compatible hydraulic fluid and lubricants; 4) greaseless wicket gate bushings; 5) smooth surface finishes in conjunction with upgrades for stay vanes, wicket gates, and draft tube cone.

To address the changes in mortality associated with how the turbines are operated, new technology in measurement transducers and in control systems have been used to develop control system designs to: 1) sense fish presence at each turbine and limit turbine operation to “fish friendly” modes when fish are present; 2) automatically update Kaplan turbine “digital cam surfaces” to most efficient operation at each head and flow to ensure proper optimization of operations and minimization of fish injuring flow turbulence; 3) sense active cavitation and limit turbine operation to non-cavitating conditions; and 4) optimize plant output when fish are present to achieve targeted fish passage survival based on fish presence, location, turbine passage mortality, spillway fish mortality, fish bypass characteristics, and total dissolved gas generated during spilling (Figure 4). Furthermore, new technology for generator designs can be implemented for plants with large changes in head. Particularly important for Francis units, turbine operations can be adjusted for optimum fish survival conditions independent of operating head by using adjustable speed generators and advanced control systems.

Elements of the e-"fish"-ent—Kaplan have been implemented in the rehabilitated designs installed at the Rocky Reach power plant of Chelan County P.U.D. in Washington state in the U.S. [17] and at the Bonneville project of the U.S. Corps of Engineers [18]. An even more advanced design has been developed and model tested for the Grant County P.U.D.’s Wanapum Dam [19]. These turbines feature partially or fully gapless designs as well as a mix of the other features discussed above. Fish survival testing using balloon tags at Rocky Reach showed that elimination of the gaps downstream of the blade center of rotation resulted in a 4 percent improvement in fish passage survival at lower operating powers where gap size was large [20]. Testing of the fish passage survival of the new minimum gap design at Bonneville is planned for the spring of 1999.

An environmentally enhanced Francis turbine concept was also developed. Features include: a low turbulence, high efficiency design with reduced cavitation having a reduced number of blades compared to traditional designs; a non-overhanging design for wicket gates; use of environmentally compatible hydraulic fluids for governors; greaseless wicket gate bushings; upgraded surface finishes for stay vanes, wicket gates, and draft tube cone; adjustable speed generator for wide head range plants; an advanced control system for speed adjustment and/or for optimized energy generation while operating units and the plant at flows maximizing fish passage survival when fish are present in the flow. Table 1 illustrates the impact of turbine size and number of blades on fish survival.

	Number of blades	Using D=1.0m Survival Probability %	Using D=5.4m Survival Probability %
New	25	89.7	98.1
Original	18	92.6	98.6
New	15	93.6	98.9
New	13	94.6	99.0
New	11	95.5	99.2

Table 1. Considering only strike induce mortality for Francis turbines of two different sizes (D) and various number of runner blades, large turbines with smaller number of blades provide better conditions for survival.

Further research is underway. Advanced zonal matrix models to estimate fish passage survival as a consequence of turbine geometry and operational characteristics are being developed and evaluated. Figure 5 shows the results of such a model where lines of constant fish passage survival are shown superimposed on the turbine efficiency performance characteristics. Field tests of eel survival for a propeller turbine design correlated well with predicted survival [14] using the zonal matrix model.

In another application of new technology, an advanced computational method for estimating trajectories of fish-like bodies passing through hydropower installations is currently under development. The method is based on the assumption that a fish swimming through the complex, three-dimensional flow field of a hydro turbine (obtained via a separate 3-D viscous calculation) can be approximated as a body of simplified, yet fish-like geometry moving through the precomputed flow field. The motion of such a "virtual fish" is governed by a set of differential equations that account for the fish mass and various flow-induced forces. This model can not only be used to estimate the trajectory of a virtual fish from the forebay to the tailrace (Figure 6), but can also provide very specific information about a variety of flow-induced loads to fish passing through various zones of turbine flow (Figure 7) [21]

Use of these advanced tools in conjunction with well-planned and well-executed physical tests to validate the injury mechanisms will help turbine designers and biologists improve fish passage survival and enhance the image of hydra power as "green power" and a renewable resource.

Increasing Dissolved Oxygen in Turbine Discharges

Development of methods for increasing dissolved oxygen in turbine discharges has been underway for nearly 50 years. In the last 10 years, significant progress has been made. TVA has been a consistent driver of these developments. Through its Norris Engineering Laboratory, TVA has developed reliable line diffuser technologies for low cost aeration of reservoirs upstream of hydro plants [22] and effective labyrinth weirs (see Figure 8) and infuser weirs for aerating flows downstream from hydra plants [23]. The most cost-effective technology for Francis turbines, where site conditions support it, has been found to be the use of the low pressures induced by the water flowing through the turbine to aerate the flow.

For upgrades and new construction an ongoing joint development effort by TVA and Voith Hydro, Inc., has made substantial improvements in the design of the "auto-venting" turbine (AVT) [23, 24, 25]. Extensive development with scale models and field tests was used to validate aerating concepts and determine key parameters affecting aeration performance. Specially shaped turbine component geometries were developed for enhancing low pressures at locations for aeration outlets in the turbine water passage, for drawing air into an efficiently absorbed bubble cloud as a natural consequence of the design, and for minimizing power lost as a consequence of aeration. New methods were also developed to manufacture turbine components for effective aeration.

TVA's Norris Dam was selected as the first site to demonstrate this technology. The two Norris AVT units contain options to aerate the flow through central, distributed, and peripheral outlets at the exit of the turbines.

In testing the new auto-venting turbines, measurements are required to maximize the environmental and hydraulic performance of the aeration options. The environmental performance is evaluated primarily by the amount of DO uptake, while the hydraulic performance is based on the amount of aeration-induced efficiency loss. At Norris (Figure 9), each aeration option has been tested [27, 28] in single and combined operation over a wide range of turbine flow conditions. For environmental performance, results show that up to 5.5 mg/L of additional DO uptake can be obtained for single unit operation with all aeration options operating. In this case, the amount of air aspirated by the turbine is more than twice that obtained in the origi-

nal turbines with hub baffles. To meet the 6.0 mg/L target that has been established for the project, an additional 0.5 mg/L of DO improvement is obtained by the flow over a re-regulation weir downstream from the powerhouse. For hydraulic performance, efficiency losses ranging from 0 to 4 percent are obtained, depending on the operating condition and the aeration options. Compared to the original turbines at the plant, these specially designed replacement units provide overall efficiency and capacity improvements of 3.5 and 10percent, respectively [28]. The new runners also have shown significant reductions in both cavitation and vibration.

In general, the environmental and hydraulic performance of a given option varies with the site head and site power output. Under these conditions, the options used to meet a target DO can be strategically chosen to minimize the aeration-induced efficiency loss. As an example, consider the 1996 DO data for the new units at Norris, shown in Figure 10. Turbine aeration was initiated in July, when the scroll case DO began to drop. Throughout the low DO season, based on the head, power, and required DO uptake, a mix of aeration options was used. Aeration ended in November after reservoir turnover. On the average, the DO downstream of the project was maintained near the 6.0 mg/L target (except for a period when aeration was disrupted for an extreme series of performance tests of the new units). During the same period, the average aeration-induced turbine efficiency loss was about 1.9 percent.

As is the case with improvements to fish passage survival, additional research is underway to further improve designs for aerating turbines. In one project, computer flow simulations using advanced numerical methods have been developed to model the processes involved in increasing the effectiveness of aeration. "Virtual bubbles" injected into turbine flows are being used to calculate bubble size and oxygen transfer efficiency (Fig. 11, 12). Through the use of the advanced numerical simulation, oxygen uptake efficiency as a function of changing design and operating parameters can be further refined. Improved software to calculate the influence of aspirated air on turbine performance and on the pressure at the air admission point is being studied, and design of improved mechanical systems for transporting air to critical locations is underway. Field tests to verify design assumptions continue to play an important role in improving the methodology.

Summary

This paper has reviewed some of the activities and innovative technologies which are currently being used to improve the environmental compatibility of hydropower and to increase its energy generation potential. Rehabilitation of existing hydroplants incorporating new fish-friendly runner designs, aerating turbines, and advanced control systems for environmental optimization is providing improved environmental compatibility as well as increasing generated revenue and reducing maintenance costs. Testing of prototype solutions has indicated that effective improvements are being achieved, improving water quality at hydra sites and reducing hydro's impact on aquatic life. Progressive utilities are working hard to implement these new developments and to operate their hydro systems to balance environmental responsibility and economical power generation.

Significant progress is being made in removing the "tarnish" from hydro's image and supporting hydro's legitimate role as a clean, environmentally sound, renewable, and affordable resource. These advanced technologies and the insights from ongoing R&D are playing a key role in making hydra "shine." The results of the recent improvements in turbine design have been verified at the first test installations. Additional research is needed to refine fish damage models and additional testing must be conducted to enhance the understanding developed to date and to verify the applicability of the new designs to a wider range of projects.

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THE ADVANCED HYDROPOWER TURBINE SYSTEM PROGRAM[1]

AN ENVIRONMENTALLY FRIENDLY TURBINE

Program Update

What: The Advanced Hydropower Turbine Systems (AHTS) program seeks to develop turbine and control systems that will allow fish to pass more safely through a hydropower facility. A major technical goal is the reduction of turbine-induced fish mortality to 2 percent or less compared to current levels ranging up to 30 percent or greater. The program also addresses other fish habitat issues such as raising dissolved oxygen levels in the water, eliminating pollutants associated with turbine mechanics and improving turbine management to produce minimum stream flows to support aquatic life.

Who: A partnership between the Department of Energy, the Hydropower Research Foundation, Inc. (a consortium of companies organized by the National Hydropower Association), and two Teams comprising engineers, manufacturers, universities, fish biologists, and plant operators.

Phases: The program is set to begin Phase II and III when new resources will be used to test the concepts developed in Phase I. Phase I resulted in four turbine design concepts to improve fish passage; Team 1 developed three design concepts that are modifications of existing turbine designs, known as Kaplan and Francis turbines, and Team 2 developed a completely new turbine wheel, or "runner". Once testing of the Team 2 design has been completed using pilot scale turbines and live fish, Phase III can begin with full-scale prototypes to be built and tested at operating hydropower plants. Team 1 designs are ready for Phase III full-scale prototype testing, and being integrated into ongoing rehabilitation projects.

Funding: Since 1994, the program has received approximately $4 million with industry spending an additional $10 million in design development. The AHTS program is scheduled for additional funding consideration. Congress appropriated $2 million for FY 1999, a significant increase from the $750,000 in Federal funding the program received last year. $35 million for continued Phase II and III testing are being requested for fiscal years 2000–01.

The Turbine Concepts

Modified Kaplan: Eliminating runner gaps, improved blade shapes and an advanced control system to sense the presence of fish are some modifications to a Kaplan turbine designed by the Voith Hydro, Inc. led team of engineers, biologists and university researchers that may increase survival rates to 98 percent according to one preliminary study. These modifications, usable today at existing hydro plants, also result in more efficient energy production, increasing the value of the turbine to the owner. Bonneville Dam on the Columbia River is installing an advanced "minimum gap" turbine now which is scheduled to go into operation in early 1999. A replacement turbine with even more advanced "fish friendly" features has been developed and scale model tested for the Wanapum Dam on the mid-Columbia River. The manufacture and conversion of the existing turbines at Wanapum Dam into this more advanced design is waiting for regulatory agreements to allow its productive use. A control system to sense the presence of fish and operate turbines at their points of maximum fish passage survival when fish are present has also been developed to work with existing or the advanced design Kaplan and is ready for Phase III evaluation now.

Modified Francis: Fewer blades, improved blade shapes and larger spaces between blades make this turbine act more like a revolving door for fish passage. Several of these "lower blade number" designs have been installed and are operating. Another revolution in design is the use of hollow blades and aerating holes that increase the amount of dissolved oxygen in water passing through the turbine. This helps fish thrive in waters below dams in the Southeastern part of the U.S. . An aerating turbine, jointly developed by Voith Hydro, Inc. and TVA has been installed at TVA's Norris Dam. Another aerating turbine is currently being manufactured for Duke Power's Wateree project. Further refinements could be incorporated into U.

S. Army Corps of Engineers projects currently funded for conventional turbine rehabilitation.

Spiral blade design: Only two or three blades and an elongated helical shape define the new runner developed jointly by Alden Research Laboratory, Inc. (ARL) and Northern Research and Engineering Corporation (NREC). This turbine has the potential to approach 100 percent fish survival. Because of its reduced power generation characteristics, and its size, it is mostly suited for new hydra projects, or for installation in fish bypass flows.

The Big Picture: The successful completion of the Advanced Hydropower Turbine Systems program could greatly enhance the nation's ability to produce a domestic source of clean and renewable electricity while lessening, or even eliminating, impacts to fish and fish habitats. Additional benefits include further reductions in greenhouse gas emissions and establishing a competitive edge for U.S. exports of turbine technology.

Advanced Hydropower Technology

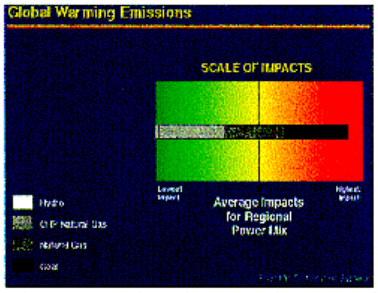
Fish Friendly Turbines

Richard K. Fisher, Jr.
Vice President, Technology

VOITH HYDRO
POWER GENERATION

Moving Toward Environmentally More-Compatible Hydro Power

- Contributes significantly to nation's power generation
  - It's domestic
  - It's reliable
  - It's renewable
- Can contribute "near term" to reducing Greenhouse gasses
- Has tarnished image
- Can be improved
- Systems can be managed to maximize benefits to all stakeholders

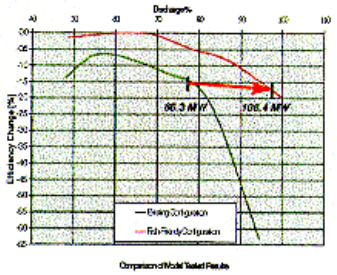


ISO 14000 provides methodology to measure environmental impacts

VOITH HYDRO
POWER GENERATION

Advanced Hydro Turbine System (AHTS) Project

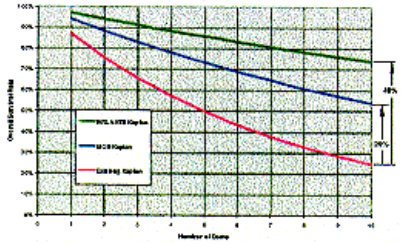
- An industry and government cooperative project
- Working together to remove environmental tarnish from hydro-power
  - Founded by 500 K$ industry grant
  - government contributing through DOE
- 3 Phases in project
- Phase Ia complete
- Developed 4 design concepts
  - Fish Passage through hydro sites (3)
  - Dissolved Oxygen in hydro plant discharge (1)
- Voith's concepts are win-win for industry
  - Addresses 70000 MW existing hydro
  - Increasing environmental compatibility
  - Increasing energy generation



VOITH HYDRO
POWER GENERATION

Fish Passage

- Small changes can lead to large overall survival improvement on Columbia River system

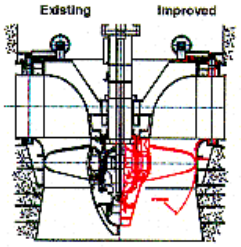


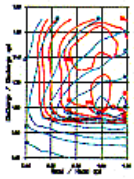
- AHTS goal: increase fish passage survival through hydro sites

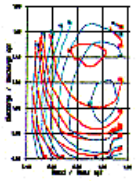
	Today	Target
-- Large Kaplan Turbine	80% to 94%	98+%
-- Fish bypass	95% to 98%	minimize
-- Spill	95% to 99%	minimize

VOITH HYDRO
POWER GENERATION

Examples

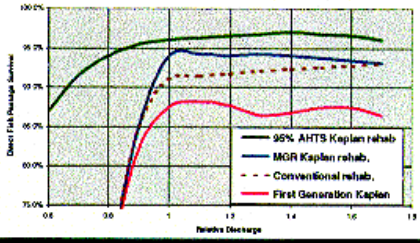






Existing Possible today

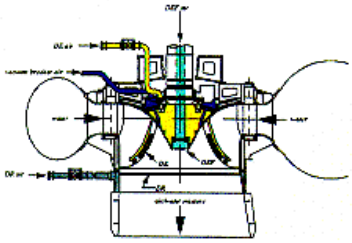
- Minimum gap
- High efficiency
- Special blade shapes
- No oil / grease
- Smooth surfaces
- Advanced control system



VOITH HYDRO
POWER GENERATION

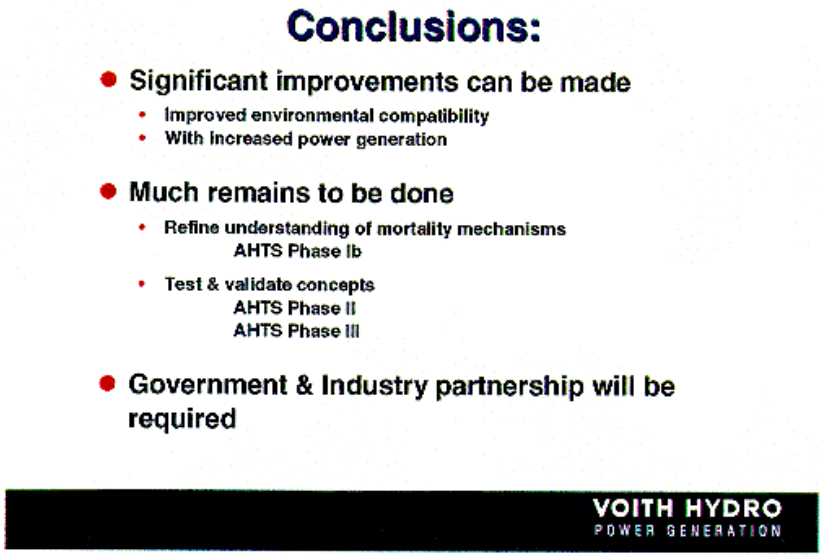
Dissolved Oxygen

- Largest fish survival problem in southeastern US
- TVA and Voith have been driving this technology for TVA's system



- AHTS design concept
  - Multiple effective aeration locations
  - Advanced DO sensors
  - Advanced control system
  - Discharge control
- Environmental Optimization
  - Minimize impacts on generation
  - Maximize DO improvements
  - Optimize minimum flows

VOITH HYDRO
POWER GENERATION



HYDROPOWER AND U.S. INITIATIVE ON REDUCING GREENHOUSE GAS EMISSIONS

(By Michael J. Sale and Marilyn A. Brown, Oak Ridge National Laboratory,[1] Oak Ridge, Tennessee, USA)

ABSTRACT

In preparation for international efforts to reduce greenhouse gas (GHG) emissions, the U.S. energy production industry has been the subject of important, new studies. These studies provide an opportunity to examine the role of hydropower In future energy production. Existing hydropower generation is declining, due to combination of real and perceived environmental problems, regulatory pressures, and changes in energy economics (deregulation, unresolved environmental problems that make maintenance of hydropower more costly than new, natural gas-based power plants, etc.). However, hydropower currently represents about 70 million metric tons of carbon dioxide emissions avoided annually. If advanced hydropower technology can be developed that minimizes adverse environmental effects, hydropower can make significant new contributions to GHG reductions. The hydropower industry should embrace the GHG Reduction Initiative, because the initiative promises to be a route to rejuvenating hydropower R&D and clean energy production.

Background

In July 1998, President Clinton announced a new campaign to address the issue of climate change with educational and action-oriented programs The fact that concentrations of carbon dioxide (CO_2) and other greenhouse gases (GHG) have been increasing in the global atmosphere at unprecedented rates is well established. Theory predicts that such increases will be accompanied by increases in atmospheric temperatures and with changes in global hydrologic cycles A panel of seven eminent scientists, including three Nobel Prize winners, presented evidence to the President and to the public showing that these predicted changes are being detected. The President responded with a broad, new initiative to reduce greenhouse gas emissions in the U.S.

Much of the President's new initiative was in preparation for the international treaty conference that was held in Kyoto, Japan, in December 1997. That conference concluded with a proposed protocol for reducing global carbon emissions. The U.S. contribution to the Kyoto Protocol, assuming it is ratified in the U.S., will be to re-

[1] Oak Ridge National Laboratory is managed by Lockheed-Martin Energy Research Corporation, Inc., under contract DE-AC05–960R22464 with the U.S. Department of Energy.

duce carbon emissions to approximately 7 percent below 1990 levels by the years 2008–2012. U.S. carbon emissions in 1990 have been estimated at 1,620 million metric tons (MtC) (EIA 1996a). Due to continued economic growth, these emissions are predicted to increase 34 percent by 2010 (Hakes 1998). Although these numbers are subject to much debate and revision, present carbon emissions would probably have to be reduced by 500 MtC/yr or more to satisfy the Kyoto Protocol.

Energy production accounts for about one third of the carbon emissions in the U S., therefore any actions to reduce these emissions will involve the energy sector. Although hydropower's current contribution to reduction of carbon emissions in the U.S. is relatively small compared to all emissions (Figure b, the hydropower industry can have an important role in managing carbon emissions. This paper examines the treatment of hydropower in the current GHG reduction initiative and describes how the hydropower industry can contribute to managing climate change. Additional developments in this area can be expected as debate continues this year.

Recent Studies and Recommendations Relevant to Hydropower

Several important studies have been produced recently in support of the GHG Reduction Initiative and other energy planning activities. These reports include the following:

- the Presidents Committee of Advisors on Science and Technology (PCAST) completed a major report on Federal energy research and development (R&D) needs in November 1997 (PCAST 1997),
- the U.S. Department of Energy (DOE) national laboratories produced two studies of alternative ways to meet carbon emission reduction goals—the "5-lab" study (IWG 1997) and the "11 -lab study" (NLD 1997)1
- in preparation for the 1997 Kyoto meeting, the U.S. Department of Interior and the U.S. Agency for International Development produced a report on environmental and social consequences of hydropower development (DOT-AID 1997), DOE conducted a new process to develop a Comprehensive National Energy Strategy and issued a draft and final plans on this subject (DOE 1998), and
- the Presidents FY 1999 budget request included new funding for various parts of the GHG reduction initiative.

PCAST recommendations

The PCAST report reviewed the current national energy R&D portfolio and made recommendations on how to ensure that national energy and environment needs will be met in the next century. This independent, non-federal body of experts concluded that significantly more government R&D is needed (i.e., increase of $1 billion over 5 years), especially in areas where investments can complement, leverage, or catalyze work in the private sector. The trend that public sector R&D investments are falling sharply (38 percent reduction between 1993 and 1996) was noted as a concern. Renewable energy technologies were targeted for the second largest increase in R&D spending due to the promise of large public benefits as clean energy production. With regard to hydropower, PCAST stated strongly that insufficient investments were being made to sustain or to increase current production. Additional R&D was recommended for a new generation of hydropower technologies that is less damaging to the environment. Although strong statements in support of hydropower are contained in the body of the PCAST report, hydropower is not highlighted among renewable technologies in the Press Release or the Executive Summary.

DOE Laboratory facings

Two studies were conduced jointly by the DOE national laboratories in 1997 and 1998 to identify technologies that could be used to meet the challenge of reducing GHGs. Commonly know as the "5-Lab" (IWG 1997) and the "11-Lab" (NLD 1997) studies, these reports evaluated a range of different technology options available now and in the future. The lab studies did not prioritize solutions, but they did recommend a sequence of alternatives over the next 30 years, with energy efficiency alternatives first; clean, renewable technologies second; and carbon sequestration approaches last. Hydropower was usually listed among the diversity of renewable, "clean energy" technologies that were recommended, but it was usually dropped out of the renewables list in report summaries. The lab studies also emphasized an R. D & D strategy in partnership with the private sector: research, development, and demonstration.

DOI-AID report on hydropower

As part of the background papers informing participants at the Kyoto conference on key subject, a whitepaper was prepared on the environmental and social consequences of hydropower development (DOT-AID 1997). This report acknowledged that hydropower is essential to the U.S. and global power sectors and that hydro-

power development had both positive and negative effects. While global hydroelectric capacity is increasing at 2–3 percent per year, it is decreasing in the U.S. Projections for greater hydropower development are being rejected by world bodies such as the World Energy Council and the Intergovernmental Panel on Climate Change, because they do not account for unacceptable social and environmental impacts. Among the negative impacts of hydropower emphasized in the DOI-AID report are:

- forced resettlement of people from inundated lands; loss of biodiversity;
- disruption of water and sediment regimes in rivers, estuaries, and wetlands;
- emissions of GEIGs at some sites;
- outbreaks of water-borne diseases; and intensification of regional and transnational water rights conflicts.

The DOI-AID report does acknowledge that these adverse impacts are not associated with ail hydropower project types and that significant progress is being made in modifying project operations to reduce impacts. Unfortunately, these qualifications are too often lost in strategic energy planning

Comprehensive National Energy Strategy

In January 1998, DOE began an new national energy planning effort called the Comprehensive National Energy Strategy (CNES) (DOE 1998). CNES goals are to:

- improve system-wide energy efficiencies,
- ensure against energy disruptions,
- promote energy production/use compatible with health and environmental values, expand future energy choices, and
- cooperate on international energy issues.

In the draft CNES report, only one hydropower-related strategy was listed under the goal of efficiency improvements: increase the efficiency of existing Federal hydropower facilities by 2010. There was another strategy targeted at providing Federal technical support in adopting renewable technologies, but hydropower is not identified. Under the goal of promoting healthy and environmentally sound energy production, the CNES proposes a strategy of doubling nonhydropower renewable electrical generation to a total of 25 GW by 2010. After regional hearings were held in February in Dallas, San Francisco, and Washington, DC, this latter strategy was expanded to include maintaining the viability of existing hydropower sources. However, hydropower is not a major part of CNES.

Budget requests

The fiscal year 1999 Federal budget proposed by the President included an increase in DOE's hydropower research allocation to $4 million for the Advanced Hydropower Turbine System program (Sale et al. 1997). By May of this year, DOE officials were making public statements in support of hydropower R&D, recognizing that reductions in the existing hydropower base will have serious environmental and economic impacts on the nation. Unfortunately, final outcome of future budgets rests in the hands of Congress, where support for all Kyoto-related initiatives is not strong.

Current Carbon Reduction Contributions from Hydropower

Hydropower is already making significant contributions to mitigating U.S. carbon emissions, because it is essentially GHG-free and produces approximately 8 percent of all domestically produced electricity. In 1995, conventional hydropower capacity in the U.S. was 78,480 MW and hydroelectric generation totaled 310 billion kWh (EIA 1996b). The average carbon intensity factor (carbon emitted per kWh, expressed as gmC/kWh) for domestic electrical production is 160 gm carbon per kWh. Using this average carbon intensity value, hydropower offset 50 MtC/yr. This contribution could be increased by more than So percent, if new hydropower could be developed.

Alternatives for new hydroelectricity

There are four different approaches to increase hydroelectric production in the U.S.:

- make improvements at existing Federal and non-federal hydropower projects,
- construct new powerplants at existing dams that currently have no hydropower generation capabilities,
- reduce the generation losses that are occurring in the relicensing of non-federal projects, and
- construct new projects at new dams or diversions

The environmental effects of these different approaches range from zero to potentially significant. The first two that involve existing dams have little or no adverse environmental effects, because dam construction, which has the biggest effect on the

environment, has already occurred (Railsback et al. 1991). The adverse environmental effects of relicensing losses would likely also be minimal, because only minor impacts would be allowed through the extensive FERC relicensing process. Impacts from construction of new projects would be very site-specific, but there are a large number of acceptable sites that remain undeveloped (Rinehart et al. 1997).

New capacity/energy and carbon reduction potential

Based on the best available hydropower resource assessments, hydropower can provide up to 67,000 GWh of clean energy production by the year 2010 (Table 1) and significantly more soon thereafter. The majority of this new development on the near term would be efficiency upgrades and new powerplants at existing dams (Figure 2). Note that the CNES is calling for a total of all non-hydropower renewables of 25 GW by 2010. New hydropower could exceed that total even without tapping into sites where new dams diversions would be required.

Table 1: Potential new capacity, generation, and carbon emission avoidance from future hydropower of all development types.

Year	Capacity (GW)	Generation (G Wh)	Carbon Emission Reduction (MtC)
2010	18	67,000	11
2020	33	133,000	22
2030	60	180,000	30

Carbon emission reductions

The amount of carbon emission reduction that new hydropower could be credited with depends on the carbon intensity factor for displaced energy sources, which will be changing over time. The "business-as-usual" reference case forecast by the Energy Information Agency (EIA) predicts an increase in this carbon intensity factor, from 160 gmC/kWh in 1995 to 165 gmC/kWh in 2010 and 167 gmC/kWh in 2020 (EIA 1996b). This increase reflects the forecasted decrease in the relative contribution of nuclear power, an essentially zero-carbon source of electricity. These forecasted carbon intensity factors are used to estimate the carbon reduction potential of hydropower shown in Table 1.

The carbon displacement potential of hydropower could be considerably greater, however, if efforts are initiated to decarbonize the electricity system. The introduction of a domestic carbon trading system or renewables portfolio standards, for instance, could precipitate significant shifts away from coal-based electricity generation. In such a scenario, increased hydropower could displace electricity with much higher than average carbon intensities, thereby contributing more significantly to meeting carbon emission reduction goals.

Comparison to Other Renewable Energy Technologies

Hydropower production compares very favorably to other renewable energy technologies with respect to production costs and carbon emission avoidance potential. In 1995, total electric generation from all renewable energy sources was 354,000 GWh, 87 percent of which came from conventional hydropower projects.

Cost of production

As with all energy projects, development costs for hydropower project vary significantly, depending on project design and other site-specific factors. An analysis of 21 new projects that began operation in 1993 showed median capital costs of $2,000/kW (project size ranged from 125 kW to 32.4 MW). Average operation and maintenance costs for these projects was 0.75 cents/kWh, with zero fuel costs. These factors translate to a levelized cost of electricity of between 2 and 5 cents/kWh. The cost of energy production from nonhydropower renewables is generally higher than for hydropower, but continuous R&D investments are reducing these costs (Table 2).

Table 2: Range of energy production costs from renewable energy sources that compete with hydropower, assuming generation company ownership (DOE-EPRI 7997).

Comparable hydropower costs currently range from 2 to 5 cents/kWh.

	Levelized Cost of Energy (1997 cents/kWh)		
	1997	2010	1030
Biomass[1]	7.3–8.7	6.1–7.0	5.0–5.8

Table 2: Range of energy production costs from renewable energy sources that compete with hydropower, assuming generation company ownership (DOE-EPRI 7997).—Continued

Comparable hydropower costs currently range from 2 to 5 cents/kWh.

	Levelized Cost of Energy (1997 cents/kWh)		
	1997	2010	1030
Geothermal[1]	3.3–10.9	2.4–8.3	2.0–5.3
Solar Thermal[1]	– 17.3	5.2–61	4.2–6.8
Photovoltaics[2]	37.0–51.7	8.1–17.0	5.0–6.2
Wind[2]	5.0–6.4	2.5–3.1	2.3–2.8

[1] dispatchable technology
[2] intermittent technology

Barriers to Hydropower

It is clear that hydropower has the potential to make significant contributions—so why is it being ignored? The reason may be that we are still focusing too much on the mistakes of the past and not enough on the search for new solutions.

Emphasis on non-hydropower renewables

There has been and continues to be significant resistance among the energy planning community and in Congress to include hydropower among the clean-energy, renewable technologies that are favored in the GHG reduction initiative. Non-governmental organizations (NGOs), such as American Rivers and the Hydropower Reform Coalition (HRC) have been very effective in Washington in emphasizing hydropower's problems (e.g. see American Rivers message at URL address: www.amrivers.orgirunriver.html). Advocates of competing renewable energy sources have also been successful in telling positive stories about their technologies, often to the detriment of hydropower. The specific ONES goal for "non-hydropower renewables" is a reflection of these messages. Another major study of the development costs of renewable energy sources ignored hydropower completely (DOE and EPRI 1997).

Environmental challenges and regulatory overhead

It is a fact that hydropower development in the past has had unexpected and unacceptable environmental impacts (e.g., Mattice 1991). In addition to the environmental challenges that hydropower faces nonfederal hydropower development carries a regulatory overhead that is exceeded only by the nuclear power industry Legislation such as the Electric Consumers Protection Act of 1986 and subsequent Judicial interpretations have created a gauntlet of regulatory processes that allow an extraordinary number of review processes to condition hydropower development

Conclusions and Recommendations

The hydropower industry continues to be faced with both challenges and opportunities. Action is needed to generate congressional understanding and support for the important role that hydropower can play in future energy needs. A strong, environmentally oriented R&C) program is also essential to hydropower's future.

Congressional support and collaborative actions

Everyone with an interest in hydropower should be making their presence known to their congressional representatives. Progress is definitely being made here, with the leadership of the National Hydropower Association and others. However, the positive aspects of hydropower must be heard more clearly.

Collaborative efforts with the environmental NGOs is also important. For example, the HRC is talking about implementing some type of "seal of approval" so that clean (i.e., environmentally acceptable) hydropower can be included among desirable renewables. There is a very real opportunity for joint development of renewable portfolio standards that can ensure hydropower's future, and it should be pursed jointly. The World Conservation Union and World Bank are forming a World Commission on Dams that has a similar mandate to identify widely accepted standards, guidelines and criteria for water projects.

Research and development

On June 26, 1997, President Clinton proposed that "the way to simultaneously meet the twin goals of reducing GHG and growing the economy was to invest more in the technologies of the future". The hydropower industry must work hard to ensure that it is among those future technologies. Hydropower R&D that is aimed at making existing technology more compatible with the environment is essential if hy-

dropower is to be a contributor to GHG reduction goals. Such efforts are truly a win-win situation, because they will allow the correction of past problems and allow for additional GHG-free energy production in the future.

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HYDROPOWER'S CONTRIBUTION TO CARBON DIOXIDE EMISSION REDUCTION

(By James E. Francfort, Idaho National Engineering and Environmental Laboratory, November 1997)

The annual carbon dioxide emissions currently avoided by the use of hydropower in electricity generation is 142 million metric tons, and it has a carbon tax value of $7.1 billion. Developing the identified additional hydropower capacity can yield an additional 34 million tons annually of avoided carbon dioxide emissions, with a value of $1.7 billion in carbon taxes (Table 1). The total annual avoided emissions can exceed 176 million metric tons, with value of $8.8 billion.

Table 1. Hydropower's contribution to avoiding carbon dioxide emissions

	Avoided annual carbon dioxide emissions (metric tons)	Potential carbon tax value
Current annual generation	141,986,065	$7,099,303,225
Identified additional generation	34,598,376	$1,729,915,796
Total annual contribution	176,584,441	$8,$39,222,021

Current Annual Hydropower Generation—Avoided Emissions

Hydropower, by the nature of its fuel source (water) and the non-combustion way in which it captures and converts the energy of falling water into electrical energy via the water turbine and generator set, lowers the amount of carbon dioxide emitted during the production of electricity The annual reduction in carbon dioxide emissions can be calculated as follows:

Converting the pounds of carbon dioxide per million Btu (Table 2) into the pounds per kilowatt-hour (kWh) value by multiplying Table 2 by the Btu per kWh (Table 3) and dividing by 1 million to convert to emission pounds per Btu instead of per million Btu:

207.7 x 10,296 / 1,000,000 = 2.14 pounds of emissions per kWh

Multiplying 2.14 by the average annual hydropower kWh energy (Table 4), divided by 7,000 to convert to tons and multiply by 0.9718 to convert to metric tons:

2.14 x 278,816,144,000 / 2000 x 0.90718 = 270,449,647 metric tons

It is assumed that only 52.5 percent of the hydropower is replacing coal generation, given that coal comprises 52.5 percent of the electric generation in the United States (Table 5), so the metric tons is multiplied by 52.5 percent:

270,449,647 x 0.525 = 141,986,065 metric tons of carbon dioxide emissions annually omitted by hydropower generation in the United States.

Given the S50 per acetic ton carbon tax, the hydropower emissions has a value of $7.1 billion:

141,986,065 x 550—$7,099,303,225

Potential Additional Avoided Hydropower Generation—Emissions Avoided

DOE has identified the potential hydropower capacity that can be developed given the various environmental, legal, and institutional development constraints as totaling 34,470 MW of capacity (Table 6). Various state natural resource, water quality, and environmental quality departments have provided input to this modeling process. Because 93 percent of these identified sites with undeveloped capacity are sites the: already have either existing generation or at minimum a dam with no current generation, the addition of new capacity avoid occur at sites with current infrastructure development. Given the need to minimize carbon emissions and the absence of environmental types of constraints at these sites with undeveloped potential, a very high percentage of these sires can be successfully developed in the near term if their value in decreasing emissions is fully considered. For analysis purposes, it is assumed that only So-so of this capacity would be developed.

To convert the undeveloped capacity to kWh, tulle following equation is employed:

34,470 x 1,000 (convert to kWh) x 24 (hours) x 365 (days) x 0.45 (plant factor) x 0.50 (percent developed) = 67,940,370,000 kWh.

The 67.9 billion kWh can now be used to calculate the avoided tons of carbon dioxide emissions using the same calculations used above to calculate the current annual emissions avoided:

67,940,370,000 x 207.7 x 10,296/1,000,000/2,000 x 0.525 x 0.90718 = 34,598,376 metric tons

To find the carbon tax value of the avoided emissions multiply by $50:

34,598,376 x $50 $1,729,918,796

Table 2. Average Carbon Dioxide Emission Factors for Coal by Coal-Consuming Sector

EIA, Annual Energy Review (July 1996), Table C1

Year	Electric Utilities—Pounds of Carbon Dioxide per Million Btu
1990	207.6
1991	207.7
1992	207.7
1993	207.8
1994	207.9
Average	207.7

Table 3. Approximate heat rates for electricity

EIA, Annual Energy Review 1995, (July 1996) Table A7[1]

Year	Fossil-Fueld Steam-Electric Plants (Btu per Killowatt-hour)
1991	10,352
1992	10,302
1993	10,280
1994	10,272
1995	10,272
Average	10,296

[1]Fossil fuel defined as petroleum, coal, and natural gas.

Table 4. Conventional hydroelectric generation

EIA, Electric Power Monthly, March 1997, Table 5

Year	Thousand Kilowatt-Hours
1990	283,433,659
1991	280,060,621
1992	243,736,029
1993	269,098,329
1994	247,070,938
1995	296,377,840
1996	331,935,594
Average	278,816,144

Table 5. Electric Utilities and nonutility power producers net generation

Year	Net Generation (billion kWh)	Coal Generation (billion kWh)	Percent from coal
1992	3,083.4	1,621.1	52.6%
1993	3,196.9	1,690.0	52.9%
1994	3,253.8	1,691.6	52.0%
Average	3,178.0	1,667.6	52.5%

Table 6. Estimate of undeveloped hydropower resources in the United States

Includes 50 States. Does not include U.S. Territories

Status	Number of sites	FERC database (MW)	DOE/HES study (MW)	Percent of original estimate
49 States—sites with power	361	5,850	3,499	59.9%
49 States—sites without power	2,395	29,006	17,527	60.4%
49 States—sites undeveloped	2,398	26,710	9,617	36.0%
Idaho—all sites	360	7,685	3,827	49.8%
Totals	5,514	69,251	34,470	49.8%

STATEMENT OF COLONEL ERIC MOGREN, DEPUTY COMMANDER, NORTHWESTERN DIVISION ARMY CORPS OF ENGINEERS

Good morning, Senator, committee members, and distinguished guests, I am Colonel Eric Mogren, Deputy Commander of the Northwestern Division of the US Army Corps of Engineers. I appreciate the opportunity to testify today on topics of interest to all of us in the Pacific Northwest who have devoted much energy and resources to preservation and restoration efforts for declining stocks of salmon and steelhead.

My testimony addresses avian predation and turbine passage improvements, topics within the Corps' scope from among those listed in your agenda for today's hearing.

The topic of avian predation on juvenile salmonids in the Columbia River Estuary is of particular interest to the Corps. Recent research has indicated that colonies of Caspian terns, gulls, and cormorants in the estuary are consuming salmon and steelhead smolts as the young fish make their way to the ocean.

Caspian terns nesting on Rice Island are protected by the Migratory Bird Treaty Act. Our efforts must focus on finding a balance so we can provide suitable habitat within which both terns and salmonids can survive and prosper. Protection of the terns has been a concern raised to us by the Audubon Society, the Pacific Seabird Group, and the American Bird Conservancy.

Many populations of salmon and steelhead in the Pacific Northwest are in serious trouble, with several listed as threatened or endangered under the Endangered Species Act. Extensive effort by the Corps and other federal, state, tribal and private entities in the region have shown some positive results, but more effort is needed. The region has invested many millions of dollars over several decades to save this important resource.

Rice Island was created in 1962 by placement of dredged material. It is located 21 miles upstream of the mouth of the Columbia River. Over the years, it has become a nesting site for thousands of gulls, cormorants, and since 1387, Caspian terns. Rapid increases in Caspian tern nesting colonies were noted in the early 1990's.

Due to concerns about avian predation on the young salmon as they moved through the estuary, National Marine Fisheries Service' (NMFS) Biological Opinions on salmon and the hydropower system included a request for the Corps to evaluate avian predation in the Columbia River system. We contracted for this work with some very capable researchers, including Doctor Daniel Roby of Oregon State University, who is also here today to testify. And largely through your efforts, Senator, language in the 1996 Water Resources Development Act also recognized a potential need for research and development activities related to "estuary and near? ocean juvenile and adult salmon survival."

Results from the 1997 field research season alerted the region that avian predation may significantly affect juvenile salmonid survival in the estuary. It was estimated that Rice Island supported the largest known Caspian tern colony in North America, with over 16,000 birds in 1997. Preliminary research results from 1998 indicate that the colony has grown again by approximately 25 percent to 20,000 birds. Further, it was estimated that these birds in 1997 consumed from 6 to 25 million juvenile salmonids annually. This estimate is supported by two other research activities we funded: juvenile fish radio tracking studies; and the reading of passive-integrated-transponder, or PIT tags, found on Rice Island that had been inserted into the juvenile fish at upriver facilities. However, available science cannot yet tell us the impact of the level of predation on the recovery of listed salmon.

In a March 24, 1998 letter, NMFS requested that the Corps "take action at implementing a short-term remedy to minimize predation on the 1998 [salmonid]

outmigrants." In response, a Caspian Tern Working Group has been established that includes the Corps, NMFS, University researchers, Columbia River Inter-Tribal Fish Commission, Oregon and Washington Departments of Fish and Wildlife, Bonneville Power Administration, and US Fish and Wildlife Service.

This group has identified a potential near term plan to attempt to relocate the Caspian tern colony from Rice Island to East Sand Island, an island approximately 16 miles downstream from Rice Island. East Sand Island is where the birds first settled when they came to the Columbia River Estuary in 1384. Research on cormorants supports assumptions that terns that feed downstream from Rice Island may eat fewer salmonids and more of other fish species. In addition, studies of cormorants from Rice Island versus East Sand Island also indicate that the East Sand Island birds consume fewer juvenile salmonids as a portion of their diet.

To move the birds, several actions are planned before the start of the 1999 nesting season. Habitat on East Sand Island will be developed that is attractive to the terns. Because the birds nest on bare sand, the island will be scarified to remove vegetation and debris. Decoys and calls will be used to attract the birds to East Sand Island.

The birds will be dissuaded from settling on Rice Island by alternatives such as habitat alteration, to be accomplished by seeding with wheat, grasses and legumes: and/or non-lethal disturbance of the birds to disrupt nesting and feeding patterns. A monitoring program will be implemented to assess effects on the terns and to verify reduced salmonid predation.

Environmental documentation in compliance with the National Environmental Policy Act, or NEPA, will be completed prior to implementation of this plan. The Corps is drafting an environmental assessment under NEPA to address these actions. We are also preparing to implement habitat development on East Sand Island, and establish vegetation on Rice Island to help dissuade the birds from nesting on these islands.

The plan is not without controversy. The birds have their supporters as do the salmon. I believe the proposed plan balances these concerns, but we will see what responses we receive when we issue the environmental assessment toward the end of this month.

I have been working with the other Federal officials, namely, Will Stelle from NMFS and Ann Badgley from Fish and Wildlife Service, to share the responsibility for this issue. While this is a multi-agency effort involving some of the best experts in the field, there is no guarantee that this near term plan is scientifically supportable at this time, or that the plan will be fully successful. This attests to the need for a combined agency approach to a long-term solution to this problem.

I would like to address now the topic of safer turbine passage for juvenile fish. While juvenile fish bypass systems, increased spillway passage, and truck and barge transport for juvenile fish have greatly improved juvenile fish passage at the Corps' eight lower Columbia and Snake river dams, a percentage of fish continue to pass the dams through turbines. The survival rate for turbine passage is estimated at between 89 and 94 percent. While this may seem to be a good survival rate, it diminishes considerably when multiplied by passage through as many as eight dams.

The Corps currently has a turbine passage improvements program under way as part of its Columbia River Fish Mitigation (CRFM) project. This turbine program developed from a Turbine Passage Survival workshop we held in 1995 to discuss with experts the possible mechanisms affecting survival of juveniles through turbines. At that time, we were in the process of rehabilitating the turbines at Bonneville Dam First powerhouse; Voith is our primary contractor.

An idea that developed that is now incorporated into the design of the Bonneville Dam rehabilitation is the concept of minimum gap runners. It is believed that this design change will result in improved juvenile survival. We will have the first units available in 1999 for testing of this concept.

In addition, in 1997 we initiated a Turbine Passage Survival Program under CRFM. This is a 4-year program to identify potential areas of injury to fish in turbine passage and to design better turbines to reduce this injury. Our plan includes model studies and, if warranted, the field testing of prototypes. We have recently released an annual report that addresses the direction of this program. Under the constrained fiscal year 1999 appropriation to CRFM, some of the turbine studies program activities may not be funded. In coordination with regional interests, we are presently determining which actions will be able to continue in fiscal year 1999.

Thank you for the opportunity to participate in today's hearing. I will be happy to answer any questions you may have.

STATEMENT OF DANNY CONSENSTEIN, COLUMBIA BASIN COORDINATOR, NATIONAL MARINE FISHERIES SERVICE, DEPARTMENT OF COMMERCE

Mr. Chairman, members of the committee, thank you for the opportunity to testify before you today on Columbia and Snake River salmon recovery. My name is Danny Consenstein, and I am the Columbia Basin Coordinator for the National Marine Fisheries Service.

I would like to discuss our efforts to protect and recover imperiled salmon and steelhead stocks throughout the Columbia Basin. The species that have been listed or proposed for listing as threatened or endangered under the Endangered Species Act have affected almost every watershed in the Basin. The salmon's life cycle is complex and its migration vast in changing ocean conditions. Hundreds of human activities have destroyed salmon habitat and brought salmon populations to the brink of extinction: timber harvest, farming, mining, irrigation and water development, road-building, urbanization, damming, dredging, hydropower operations, fishing, fish hatcheries—the list is quite long.

Viable recovery strategies must tackle all aspects of the salmon life cycle and look carefully at the ecological requirements of diverse species. We believe that a basin-wide plan can be developed in the region to restore healthy salmon runs while maintaining a strong, healthy economy in the Pacific Northwest. We are committed to using the best available science and a comprehensive approach. There are no quick fixes, no silver bullets.—I would like to briefly describe actions we are taking to restore these threatened stocks in the areas of 1) harvest management, 2) hatchery reforms, 3) habitat protection, and 4) improvements to the hydropower system. I would also like to describe ways we are trying to reduce predation in the river, in the estuary, and in the ocean.

Harvest

Commercial, recreational, and tribal treaty fisheries have been substantially restricted. In decades past, harvest rates on hatchery and wild stocks often ranged from 60 to 95 percent. For example, for Snake River stocks, the total fishing mortalities for spring/summer chinook have been limited to 510 percent for the past 15–20 years, and are not considered a significant impediment to recovery. Fall chinook harvest mortalities for both ocean and in-river fisheries have been reduced by 30 percent or more from pre-listing rates. For steelhead, recreational harvest is limited to marked hatchery fish only, and tribal fishing this year has been reduced from the 32 percent rate allowed under the Columbia River Fish Management Plan to a 10–15 percent rate on B-run (late-run) steelhead.

Hatcheries

Because of these ESA listings, we have proposed hatchery reforms that focus on the status of natural populations. Federal agencies have consistently advocated use of locally adapted broods. In the future, we may advocate more aggressive use of hatcheries in areas where the risks of extinction are highest in the near term, such as captive broodstock programs similar to that for Snake River sockeye. After a broad assessment of the sub-regions of the Basin, priorities could be set about where supplementation would be used, and not used, based on the relative likelihood of successfully restoring and sustaining naturally reproducing populations. Federal fishery agencies also recognize that hatchery practices must also support our trust responsibilities to Indian tribes and congressionally-mandated mitigation programs.

Habitat

In the tributaries, land and water management actions, including water withdrawals, unscreened water diversions, stream channelization, road construction, timber harvest, livestock grazing, mining, and outdoor recreation have degraded important salmon spawning and rearing habitats. On Federal lands, the Northwest Forest Plan provides significant protection for salmon habitat on the west side of the Cascades. East of the Cascades, the Federal agencies have been working with local communities through the Interior Columbia Basin Ecosystem Management Project planning process to protect Federal lands. To protect non-federal lands, NMFS has promoted a variety of activities. We completed a major Habitat Conservation Plan with the Washington Department of Natural Resources protecting over a million acres of state-owned land in Washington State. We are coordinating with the Natural Resource Conservation Service to ensure their guidance to farmers includes measures to protect salmon habitat. We are coordinating with the Farm Service Agency to ensure that Conservation Reserve Enhancement Program dollars benefit salmon and improve water quality.

Hydropower System

To improve conditions in the mainstem Columbia and Snake Rivers, the NMFS 1995 Biological Opinion on the operation of the Federal Columbia River Power System calls for an interim policy of "spread the risk." Inriver migration conditions are being improved using techniques such as increased spills over the projects, increased flows, physical improvements to the dams, and aggressive surface bypass development and testing. The system for transporting migrating juveniles is also being improved to reduce mortalities. These interim improvements have had the result of raising survival rates of juvenile spring/summer chinook salmon through the hydra system to Bonneville Dam in the 1990's to a level that is roughly double the low-point in the 1970's. Improvements to inriver migration and transportation are being actively monitored and evaluated to provide empirical data to inform the recommendations that will be made in 1999 about the Federal hydropower system. Additional research is also being conducted on the relationship of water flows through the system to the survival of juvenile salmon.

Predation

The 1995 Draft Proposed Recovery Plan for Snake River Salmon called for actions to control predation in the migration corridor by northern pikeminnow (squawfish) and other native fish in the reservoirs, marine mammals, and birds. I would like to describe our ongoing efforts in the areas of predation by fish and marine mammals, and our recent actions to address predation.

Avian

Recent studies indicate that rapidly increasing populations of colonial nesting water birds living in the Columbia River Estuary may be having impacts on listed salmon and steelhead. We expect continuing research will be conducted to evaluate the extent and effect of that predation. NMFS believes that a short-term strategy for reducing avian predation should be developed immediately and completed for the 1999 out-migration season.

Large nesting colonies of Caspian terns and double-crested cormorants, along with thousands of nesting gulls, have become established on manmade islands in the Columbia River estuary. The islands resulted from the U. S. Army Corps of Engineers dredging of the navigation channel. Bird numbers have increased from a few hundred nesting pairs of cormorants in 1984, to 7,000 pairs of cormorants, 8,000 pairs of ferns and 10,000 pairs of large gulls in 1997. Estimates for 1998 indicate continuing increases in numbers of pisciverous birds.

The U.S. Fish and Wildlife Service (USFWS) is the principal agency charged under Federal treaties with the conservation and protection of migratory birds. The Corps of Engineers has constructed the islands, pile dikes and channel markers where the birds nest and launch their fishing forays. The Oregon Division of State Lands controls the tidelands and the islands built of dredge material. The Oregon Department of Fish and Wildlife (ODFW) and the Washington Department of Fish and Wildlife have responsibilities for both the fish and the birds in the boundary area of the estuary. NMFS has the ESA responsibility and the sustainable fishery responsibility for anadromous fish in the Columbia River. Oregon State University and the Columbia River Intertribal Fish Commission are conducting the research. Federal and state agencies have formed a Caspian Tern Working Group to investigate this issue and help identify needed research and responsible options to address potential impacts.

In the reservoirs, the northern pikeminnow management program is designed to test the hypothesis that predation by northern pikeminnow on juvenile salmon can be reduced by 50 percent by imposing a 10–20 percent exploitation rate on pikeminnow over 11 inches in length. The Management Program was initiated in 1990 in John Day Reservoir, expanded in 1991 to include the mainstem of the Columbia from the mouth to Priest Rapids Dam and the Snake River from the mouth to Hells Canyon Dam. Various fisheries have been implemented to accomplish the 10–20 percent exploitation rate including sport-reward, trap-net, longline, set-net, and dam-angling fisheries. The sport reward fishery has been the most successful. Management of fisheries in the Columbia and Snake Rivers has been shown to be effective at removing large northern pikeminnow with over 1.4 million removed (11.3 percent exploitation rate) since 1990. Losses of juvenile salmonids to predation by northern pikeminnow are estimated to have decreased to 61 percent of pre-program levels as a direct result of program implementation. However, the proportion of total pisciverous predation on salmonids attributable to the pikeminnow is not known and will vary by river reach, species, and stock.

Marine Mammals

The principal marine mammal species affecting salmon on the west coast are the increasing populations of Pacific harbor seals and California sea lions (collectively called "pinnipeds"). NMFS has monitored these populations and documented a dramatic increase over the past 20 years (5–7 percent annual increase) concurrent with increased interactions with fisheries and conflicts with other resources. NMFS has conducted a number of studies on pinniped interactions, but, where specific conflicts have been identified, management actions are limited because pinnipeds are protected under Federal law by the Marine Mammal Protection Act (MMPA). Some of the current efforts underway to assess and address pinniped problems in the Columbia River and upcoming recommendations to Congress on potential changes to the MMPA to address pinniped problems are described below.

NMFS is currently collecting data on the extent of harbor seal predation on salmon in the lower Columbia River as part of a NMFS cooperative coastwide program with the States to determine impacts of the increasing pinniped populations on ESA listed salmon and west coast ecosystems. Results of the first year of this program will be available in April 1999.

At the Willamette Falls, NMFS is conducting a cooperative program with ODFW to address the annual occurrence of a few California sea lions below the falls preying on spring chinook and steelhead. Sea lion predation has been monitored over the past 3 years and several efforts have occurred to reduce predation including placement of barriers in one fishway entrance (that passes fish but not sea lions) to keep sea lions out of the fish ladder, and use of rubber bullets and firecrackers to deter sea lions from the fishway areas. A floating trap was placed near the fishway this past spring in an attempt to capture the sea lions, but none were caught this year.

NMFS is assisting ODFW in a program to mark and track California sea lions in the Columbia River in order to determine their foraging habits and movements in the river, and to identify the specific animals that are causing problems at the Willamette Falls and other interaction sites. Over 100 sea lions have been captured on a trap in Astoria and branded over the past 2 years.

Pursuant to the 1994 amendments to the MMPA, NMFS has developed recommendations to Congress on addressing the problems with increasing pinniped populations. Last year, NMFS put out a draft report for public comment on recommendations which include lethal removal of pinnipeds in specific situations where the pinnipeds are affecting ESA listed salmon. Over 3,000 comments were received on the draft, many of which were from groups opposed to any takings of pinnipeds regardless of the impacts pinnipeds may be having on listed salmonids. The final report will be submitted to Congress in 1999 (probably in January) when Congress begins considering reauthorization of the MMPA.

Ocean and Estuarine Research

NMFS's Northwest Fisheries Science Center is conducting research to provide more information on what happens to salmon during the ocean/estuary phase of their life cycle. In looking at the ecology of the ocean and the estuary, the studies will focus on how interactions with other species affect the growth, distribution and health of individual salmon in the oceans.

It is important to remember that when we see predation problems, we see an ecosystem that is out of balance. If an ecosystem has been dramatically altered by human activities, we need to seek opportunities to protect and restore the natural processes that keep predator and prey species in proper balance.

NMFS is committed to using the best available science to develop a multi-species, basin-wide recovery plan for salmon and steelhead in the Columbia Basin. We look forward to working together with the states, tribes, and other stakeholders in the region to complete this plan by the end of next year. Thank you again for the opportunity to present the views of the National Marine Fisheries Service. I would be pleased to answer any questions you may have about my testimony.

STATEMENT OF THE AMERICAN BIRD CONSERVANCY, SUBMITTED BY GERALD A. WINEGRAD VICE PRESIDENT FOR POLICY

CASPIAN TERNS AND OTHER PISCIVOROUS BIRDS IN THE COLUMBIA RIVER BASIN

Thank you for the opportunity to submit this statement concerning salmon recovery in the Columbia and Snake Rivers and avian predation on salmon smolts. I would like to state at the beginning that because of extremely high mortality from natural and human caused sources to smolts, no one can scientifically validate any

decline adult populations of salmon due to Caspian terns. Throughout history, fish-eating birds have been blamed for declines in fisheries with virtually no credible evidence that birds are responsible for the declines of any fish populations. American Bird Conservancy is a national conservation organization dedicated to the conservation of avian species. We have a 73-member organization Policy Council that includes such organizations as the National Audubon Society, Pacific Seabird Group Environmental Defense Fund World Wildlife Fund, and the Cornell Laboratory of Ornithology. Many of our member groups are concerned with current actions and attitudes that make piscivorous birds the scapegoats for declining fish populations across the nation. As fish stocks decline throughout the U.S. and its 200 mile EEZ, incidents and efforts to kill and harass such species as Double-crested Cormorants, Great Egrets, and Caspian terns are growing. In July, 1998 nearly one thousand Double-crested Cormorants were illegally shot-gunned in their nests on Little Galloo Island In Lake Ontario. Colonies of nesting Egrets have been illegally bull-dozed in Texas, and the U.S. Fish and Wildlife Service has issued its first depredation order in 25 years allowing aquaculturists in 13 states to shoot double-crested Cormorants without permits.

The Caspian tern *(Sterna caspia)* is a large, stocky tern whose populations throughout North America were drastically reduced by feather hunting at the turn of the century. Caspian tern populations may just now be recovering from that severe perturbation. Caspian terns are long-lived, with band returns indicating that some have lived to at least 26 years of age. The Rice Island colony of 10,000 adult pairs is the largest in North America and possibly the largest colony in the world. It represents about 25 percent of the North American population of the tern and is the only known colony of its kind along the Oregon and Washington coasts. Tern habitat elsewhere in the region, such as at Grays Harbor, WA and Everett, WA, has been destroyed or managed to eradicate terns. In the written testimony of Dr. Dan Roby, he states at page 3 that ". . . Rice Island represents one of the few, if not the only, suitable nesting habitat for this species along the coast of the Pacific Northwest. This megacolony has coalesced at Rice island because there are few options." Also nesting on Rice Island are large colonies of Double-crested Cormorants *(Phalacrocorax auritus)* and Glaucous-winged/Western Gulls hybrids *(Larus glaucescens XL. occidentalis).* Terns and other migratory birds in the Columbia River have historically consumed salmon smolts as a natural part of their diet. The testimony and statements submitted at the hearing on this issue clearly established that the preliminary research indicates that the salmon portion of the Caspian terns diet consists of 90 percent hatchery fish and 10 percent wild fish. This is apparently because hatchery reared fish are more susceptible to predation than wild fish because of hatchery rearing practices that condition young salmon to forage at the surface and otherwise weaken predator avoidance behaviors. The barging of these smolt greatly decreases the time that they would normally enter the area around Rice Island and possibly leads to their being more susceptible to all avian predators. We suggest that the focus of planners and wildlife managers in the Columbia River system should be on the recovery of endangered and threatened wild salmon stocks. These wild salmon smolt are a small part of the diet of Caspian terns.

Yes, Caspian terns eat salmon smolt while nesting on Rice Island. But there is no credible scientific evidence as to how this affects adult salmon populations. This point was made at the hearing. The testimony by Dr. Dan Roby indicated that preliminary research found that Caspian terns consume an estimated 6 to 25 million smolts. However, this range is a rough estimate with "real uncertainty. Results were based on a very small sample. Further, only the first year of this 3-year study has been completed and researchers have stated that at least 3 years of data will be needed to accurately measure avian predation on juvenile salmon. We suggest that sound management decisions should await the completion of the study and that moving the world's largest Caspian tern colony is premature. Dr. Roby mentioned in his testimony the necessity of these further studies on avian predation. Even if the figure of million smolt is accepted, this is only 3 percent of the total of about 200 million smolt (hatchery released and wild) in the Columbia River system. Of these 200 million smolt, only 100 million reach the estuary because of natural mortality and human caused mortality. For example, 56 to 70 percent of Snake River chinook smolt die prior to reaching the estuary. Passage of smolt through hydro turbines kills from 6 percent to 15 percent of the fish going through the turbines. There are 13 main stem dams on the Columbia River and Stony more throughout the Columbia-Snake system. If there were no birds earing salmon smolt, human induced and natural mortality of juvenile salmonids would still be over 99 percent.

Fish-eating birds have co-existed with their prey species for many thousands of years while both birds and fish flourished. The key difference now is that human activities have greatly impaired the ability of migratory salmon to survive. 1 he Co-

lumbia River system has been greatly altered by human activities. Dams, including the 13 major mains earn Columbia River dams. block spawning and change water flows and temperature rehinges. As Danny Consenstein of NMFS testified at the hearing, there has been a significant degradation of critical salmon spawning and rearing habitat. He pointed out that logging, grazing and mining plus stream channelization and road construction have all destroyed or impaired habitat. (See his written statement submitted at the hearing). Riparian areas have been degraded, damaging how spawning, rearing, and feeding habitat through siltation and temperature change. Irrigation and other water consumption can also affect salmon. Many adult salmon are still harvested in the Columbia and from the open seas. The hatchery rearing and release program may be causing long-term genetic problems for wild salmon stocks as well as malting them more susceptible to predators and disease and reducing available food. Simply changing barging practices and release methods may greatly reduce Caspian tern predation on salmon smolt. Of course, it is easier to focus on the Caspian terns and their dispersal from Rice Island than to tackle these other problems. But as a number of witnesses mentioned at the hearing, the recovery of salmon in the Columbia River/Snake River system is dependent on resolving the FOUR H's: HYDRO, HABITAT, HARVEST, and HATCHERIES. No one at the hearing suggested that predation be added to this list nor is there any scientific basis for doing so.

In a October 1, 1998 story in the Portland Oregonian (the same edition in which an editorial called the Caspian terns "salmon munching devils"), the paper reported on a new study by a panel of "four leading scientists" that concluded that breaching few hydroelectric dams on the lower Snake River would be a "dramatically better" way to save spring chinook salmon runs than the current practice of barging salmon around the dams. lye panel concluded that breaching all four federally owned dams should provide a 79 percent chance" of restoring dwindling salmon populations within 48 years—"more than twice the chances of recovery than if barging were increased." The odds of recovery would be just 40 percent if river operations remain unchanged, according to the panel. Harvest of adult stocks of salmon and steelhead continues. Harvest rates in past decades took up to 95 percent of the adults. Today, 10 percent of Snake River spring/summer chinook are harvested and up to 15 percent of the B-run steelhead adults are still harvested in the Columbia River. Riparian areas throughout the Columbia and Snake River have been deforested and stripped of vegetation by grazing. Rather than focusing on Caspian terns eating juvenile salmon, shouldn't the focus be on dams, restoring and protecting habitat, changing hatchery practices, and restricting harvests. Removing or translocating all the fish-eating birds from Rice Island—the Caspian terns, Doublecrested Cormorants, and Hybrid Gulls—may appear to some to be a meaningful step in salmon recovery. But again, there is no evidence that such an effort will result in any population increase in adult salmon, especially in wild salmon stocks. Only by addressing all of the causes for the decline of salmonids can coho, chinook, steelhead and sockeye populations be restored. For example, primary management actions need to be implemented immediately that improve fish hatchery techniques and release. Unless and until a comprehensive approach is adopted and implemented that addresses dams, habitat degradation and loss, harvest, and hatchery breeding and release, salmon species will not recover.

ABC is concerned that decisions have been made on the trans-location of the Caspian tern colony from Rice Island before the completion of the Environmental Assessment and the required public comment period. Therefore, the comments of scientists and these of us in the conservation community will be meaningless since the panel at the hearing guaranteed the chairman that the colony of Caspian terns would be moved prior to nesting in 1999. Such a decision is premature and renders the comment period on the ESA meaningless. Any possibility of change based on public comments appears to have been ruled out. Such an action in moving 25 percent of the population of an avian species appears to warrant and require an Environmental Impact Statement under NEPA. We can endorse experimental work to enhance habitat so that some Caspian terns might select nest sites on East Sand Island. However, we object to any actions such as harassment and habitat alteration on Rice Island unless and until it is clearly established that the Caspian terns will move and breed successfully elsewhere. Testimony at the hearing indicated that it is uncertain that such a move will result in less predation as terns are opportunistic feeders and can forage as far as Rice Island from East Sand Island.

We urge the Subcommittee to support additional research to accurately determine the impact of avian predation on salmon recovery and the susceptibility of salmon to avian predation. The research should evaluate: hatchery rearing practices which increase smolt vulnerability to predation, the amount of hatchery fish as compared to wild fish consumed; potential effects of tern colony translocation on smolt con-

sumption and bird foraging behaviors; and the assumption that fish lost to bird predation would have survived to migrate to the ocean and return as adults. The U.S. Fish and Wildlife Service has been involved with long-term, intensive cormorant control programs in Maine. These efforts have failed to reverse the declining trends of adult Atlantic salmon returns. These ineffective measures underscore the need for additional research and information to determine whether avian predation is a factor that needs addressing in the salmon recovery efforts in the Columbia River. Otherwise, hundreds of thousands of dollars of public funds will be wasted on relocating Caspian terns win no discernible increase in adult salmon populations. We agree with the U.S. Fish and Wildlife Service, "Embarking on a long term strategy to address avian predation without this knowledge would be premature and would run the risk of wasting public Finds and significantly disrupting a unique population of migratory birds unnecessarily."

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